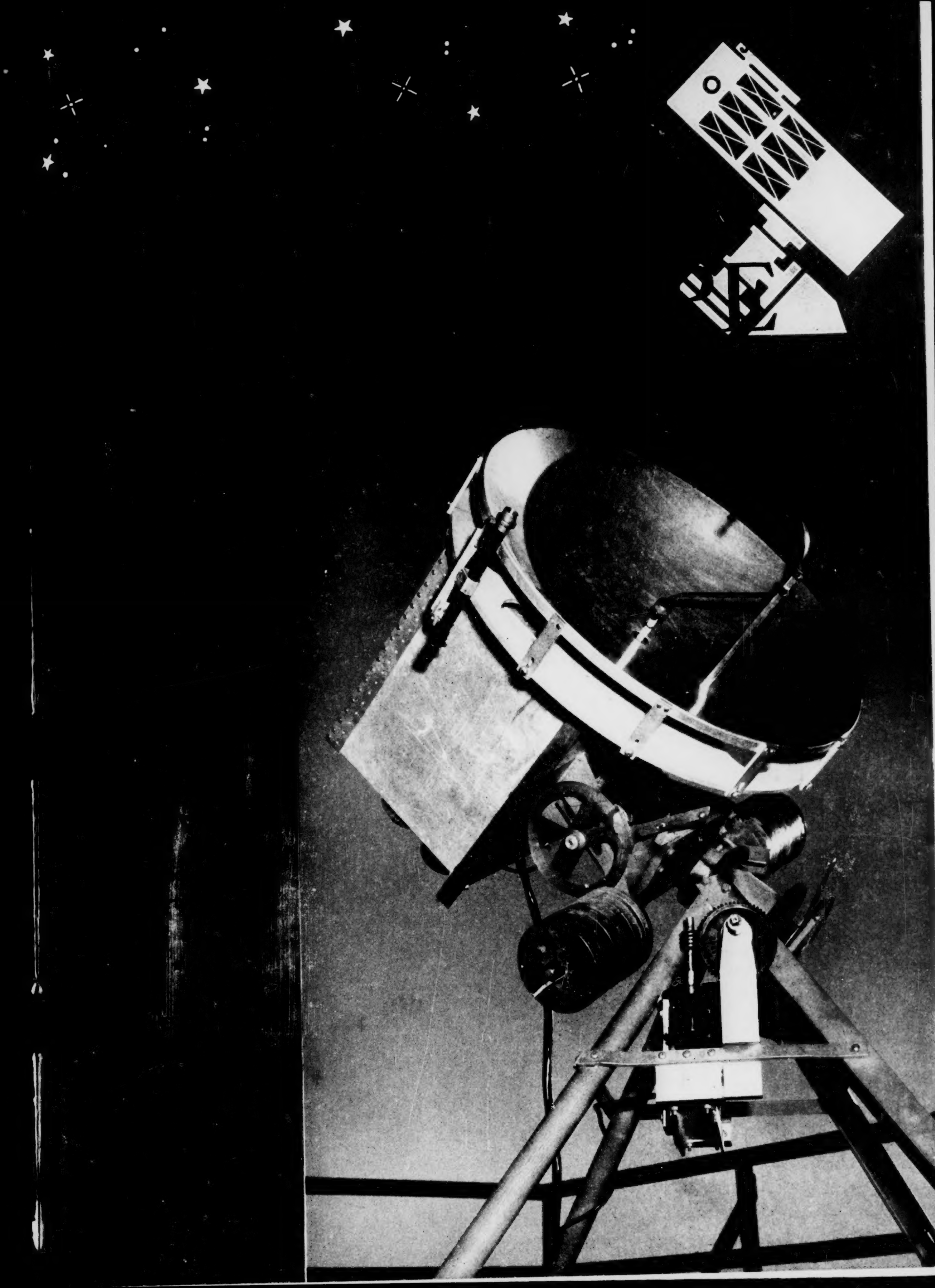


In Focus

MICROWAVE or radio astronomy is developing rapidly, and much of the observing is being done by electronic technicians who find exploration of the heavens with microwaves as fascinating as their forerunners have found optical searches into the nature of the universe. And, as the article by Dr. Otto Struve last month and this indicates, they find the radio characteristics of celestial objects to be significantly different from what we might have expected.

As the front-cover picture shows, a radio telescope bears many resemblances to an ordinary reflector. This 30-inch antenna might be compared to a 30-inch reflector with a photoelectric cell at the prime focus. When such a cell is employed to measure light from a star, in conjunction with an amplifying and continuous recording system, the astronomer is eliminated as an element in the receiving system. His only function is to guide the telescope, and his knowledge of electronics is perhaps more necessary than his knowledge of astronomy.

In resolving power, however, radio telescopes cannot equal optical ones of the same size because of the considerable difference in the wave length employed. Dr. D. O. McCoy, senior research physicist at the Collins Radio Company, states that on a wave length of 1.25 centimeters this antenna has a beam width of 1.28 degrees in the E plane of the antenna (vertical), and a beam width of 1.17 degrees in the H plane (horizontal). The E plane is in the direction of the short dimension of the waveguide, which is the circular device at the focal point of the parabolic reflector. In radio terminology, this is known as the feed system, which comes from the use of the apparatus as a transmitting antenna.

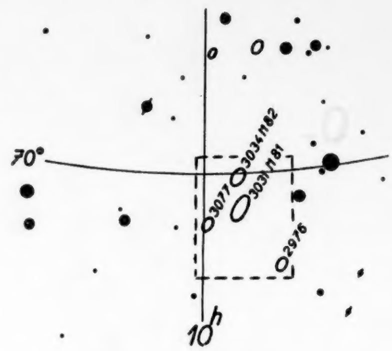
The gain of the antenna is 42.3 decibels relative to an isotropic antenna, that is, to one with no directivity located in the same position. The overall noise figure of the receiver is 14.8 decibels above that which would be produced by a perfect receiver. The receiver associated with the equipment has an intermediate frequency band width of seven megacycles, resulting in an effective overall receiver band width of 14 megacycles for this type of service.

The smallest variation in temperature that can be detected by this radio equipment is approximately one degree centigrade, which corresponds to a power variation of 1.93×10^{-16} watts. During the two lunar eclipses in 1949, this radio telescope was used under the direction of W. W. Salisbury to make observations of the temperature of the moon. Seven-minute "exposures" were made alternately on the moon and on the sky adjacent to the moon. Dr. McCoy writes:

"By turning the antenna to observe the sky at the same elevation as the moon, we obtained the amount of energy that is being received from the atmosphere only. This procedure, of course, assumes that cosmic noise from other stellar objects in the vicinity of the moon contributes a negligible amount of energy to the received signal. Based on our own observations, together with those of other organizations, this is a very satisfactory assumption. The difference of the two readings obtained is, therefore, a measure of the attenuated temperature of the moon. These readings were subsequently corrected for the atmospheric attenuation as determined by a series of measurements made at various elevation angles. The experiment included not only the run on the moon, which occupied a number of hours during each eclipse, but also an atmospheric absorption run and an equipment calibration run that were made both before and after the period of lunar observations. Calibration was obtained by replacing the feed horn in the parabolic reflector with artificial terminations at known temperatures."

The lunar eclipse observations showed no significant change in the radio temperature of the moon during totality. As the radio energy is believed to originate a few centimeters below the moon's surface, this result is in agreement with what other lines of investigation have already established: that the moon's surface material is fine dust.

Four stellar systems are pictured on the back cover this month. The largest and brightest is the spiral nebula M81, at a distance of approximately three million light-years. The other galaxies are at about the same distance, forming a group with M81. As the accompanying chart shows, these are the open spiral galaxy NGC 2976, and the irregular galaxies NGC 3077 and M82. Careful inspection of the field of the back cover reveals many other more distant galaxies.



In this chart, the dotted line encloses the area of the back-cover photograph.

SKY and TELESCOPE

VOL. IX, NO. 3
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CONTENTS

COVER: A microwave radio telescope operating on a wave length of 1.25 centimeters (24,000 megacycles). The parabolic reflector is 30 inches in diameter. Note the small "finder" telescope and the equatorial mounting. This telescope was developed by the Collins Radio Company, Cedar Rapids, Iowa, and was used to observe the two lunar eclipses of 1949. (See In Focus.)

BACK COVER: A section of a photograph taken with the 48-inch Schmidt telescope on Palomar Mountain. It shows the bright spiral M81 (NGC 3031) and three companion galaxies. Mount Wilson and Palomar Observatories photograph. (See In Focus.)

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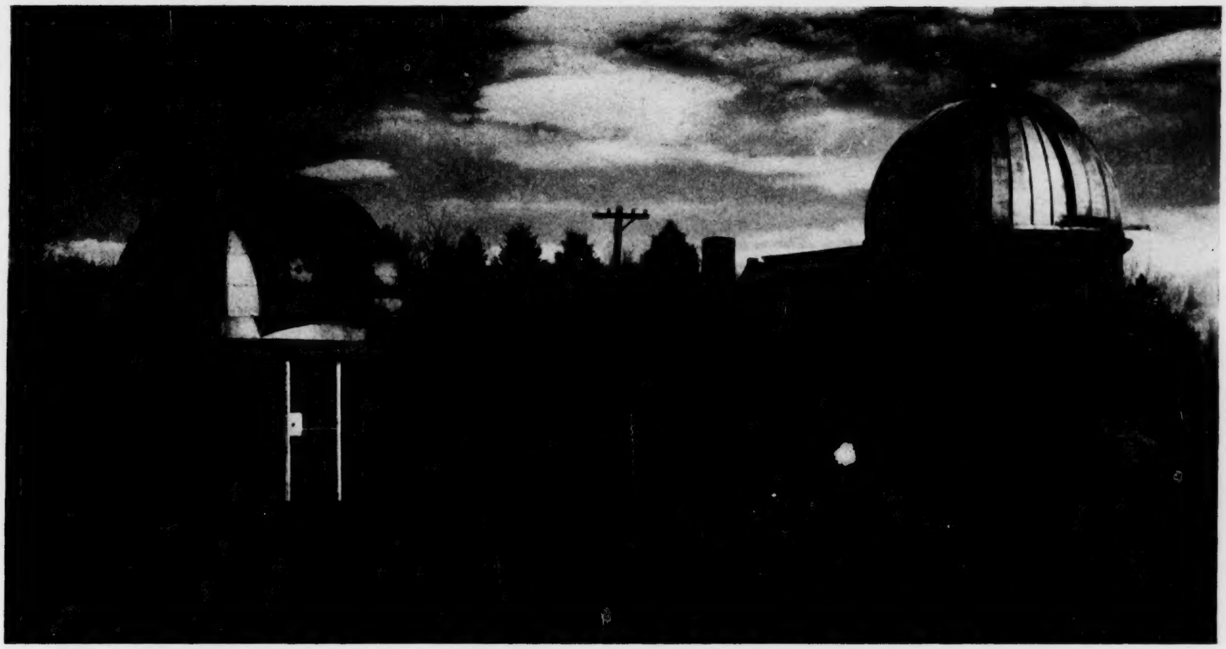


Chamberlin Observatory of the University of Denver, which has been visited by some 100,000 persons since it was opened in 1894. The new instruments are housed in the dome at the left, which has a newly widened slot. Photo by C. F. Knuckles.

Chamberlin Observatory Grows

BY THOMAS J. BARTLETT, *Chamberlin Observatory, University of Denver*

CHAMBERLIN Observatory, of the University of Denver, is boasting a "new look" and is looking toward the future with hopes of a broadening contribution to astronomy. The "new look" embraces some outward appearances and some inner aspirations.

Most recent of the outward changes was made last summer on the 13-foot dome of the students' observatory building. In former years this dome housed a fine 6-inch refracting telescope with lens by Brashear and mounting by Grubb, but in 1944, after small (and not so small) boys had broken in a number of times stealing parts and creating general havoc, the director of the observatory, Dr. Albert W. Recht, decided to dismantle this instrument and store it in the greater safety of the large building. There it remains, exiled and out of service, patiently awaiting a day of restoration.

In place of the 6-inch refractor now stands a fork mounting carrying a 12-inch Newtonian reflector and an 8-inch Schmidt camera, gifts of Clendon S. Walton, instrument maker and amateur astronomer of Wheatridge, Colo., and an 8-inch Cassegrainian reflector, gift of Robert E. Glover, civil engineer and amateur astronomer of Denver. This latter instrument, designed by Mr. Glover and built by Mr. Walton, embodies the optical principle of the Dall-Kirkham telescope. The primary mirror is not completely parabolized, but was ground beyond the sphere until tests indicated about five-eighths parabolization. This permits use of a spherical rather than a hyperbolic secondary and has two principal advantages. The first is the greater simplicity of construction, particularly on the secondary; the second is the greater ease of adjustment of the secondary. This telescope has an equivalent focal length of 74 inches and is used as the guiding telescope when either the Schmidt or the 12-inch is used for photography.

These gifts, which did not include mountings or drives, were made to Chamberlin Observatory with the understanding that we should put them to use. In fact, the reasoning behind the generosity of these men was that they were in possession of some fine optical instruments which they themselves were no longer disposed to maintain in useful service. The challenging proposition made to us, therefore, was that if we were willing and able to house them, mount them, and put them into service, we could have the instruments. We accepted that challenge.

We needed a larger lecture room to accommodate the sizable student and public groups frequently entertained at the observatory, so we proposed that an addition be built to our main building providing such a lecture room and topped with a dome suitable for housing the Walton and Glover instruments. Unfortunately, the university authorities felt that available building funds were needed more urgently for other buildings which would be used by more students.

Then it became apparent that the unused small dome (inside diameter 12 feet) of our students' observatory building might, with careful planning, be large enough. As for a mounting, both our donors had had previous experience in homemade mountings and offered their services for the design and construction of an inexpensive but serviceable mount. We hope that our brief account of how these instruments were mounted and provided with highly satisfactory driving mechanism — all at nominal cost — may be of interest to amateur and professional astronomers alike.

The German-type equatorial mount of the 6-inch refractor might possibly have been used for the 12-inch Walton reflector had it been desired to mount this alone, but since we wanted to mount with it both the Walton 8-inch Schmidt and the Glover 8-inch Cassegrainian, an open-fork mounting seemed the best answer.

The fork was made of standard 4-

A view through the widened opening showing the cluster of telescopes. Dr. Recht (below) talks things over with donors Glover (left) and Walton. The Cassegrainian is partly obscured by the Schmidt camera. The largest instrument is the 12-inch Newtonian. Photograph by O. A. Sealy, of the Denver "Post."

inch iron pipe, turned down with a lathe along the polar axis and mounted on high-quality bearings in a rugged timber framework built around the stone and masonry pier. At the north end of the polar axis was a special type of lubricated and sealed bearings obtained for us, after much searching, and furnished at cost, by Homer K. Ryder, of Denver. The three telescopes, plus a finder, were put into a wooden cradle or saddle which in turn was hung on the fork by means of the declination axis. The total cost of the mounting, for us, was of the order of 160 dollars, but if one were able to do some of his own machine and carpenter work this figure could be substantially reduced.

In conceiving a drive we decided that worm gears providing a continuous drive would be a luxury we could not afford at this time. We settled for a sector drive which runs for about two hours and is easily wound back. A piece of oak about 1 by 2 by 24 inches was cut and spliced in such a way as to make it variable in length. To one end is fastened a split-ring box, made of hardwood, which clamps to the polar axis; to the other end is attached a plywood sector which had been cut to a circular curve concentric with a cross section of the polar axis. A flexible steel cord runs from this sector to a steel pulley attached to a gear box controlled by a small synchronous electric motor. This motor does not drive the telescopes but acts as a governor which controls the speed with which they are driven. The driving power is furnished by three sash weights apparently left over when Chamberlin Observatory was built in 1890. The sidereal rate was obtained by some not-very-difficult mathematics involving the speed of the motor (2 r.p.m.), the gear ratio, the length of the sector arm, and the size of the pulley attached to the gears. Final adjustment is made by changing the length of the sector arm.

A second synchronous electric motor is used for a slow motion in right ascension. Details of this slow motion, while actually quite simple, defy simple verbal description. Next time you are in Denver, stop in at the observatory and we'll show it to you. The slow motion in declination is a simple tangent screw device.

For the benefit of anyone who may be desiring small synchronous electric motors for telescope drives or other purposes, let us recommend the type we are using. They are Hansen Synchron electric motors obtained from the Hansen Synchron Company of Princeton, Ind. This company, although normally engaged only in a wholesale business, has been most obliging in furnishing single motors to amateur astronomers. Furthermore, Mr. Walton is using one which he has had for nearly 10 years. It still works perfectly.

A feature of this mounting is that it embodies no right ascension or declination clamps in the usual sense. The split-ring box which connects the sector arm to the polar axis is adjustable as to tension, or grip, and can be set just tight enough to cause the weights to drive the instrument in all positions, but loose enough so that a bit of manual effort will turn the telescopes in hour angle without disturbing the weight or damaging the electric motor. A similar friction arrangement is worked out at the declination axis to permit easy motion and automatic clamping in this coordinate. The cost of the drive added about 70 dollars to the 160 already mentioned, and these figures represent our total cash outlay to put the telescopes in service.

Our new instruments, however, when used for photography, could not see out satisfactorily through the narrow slot with which the dome was originally built, so the Haines Scientific Instruments Company, of Englewood, N. J., was engaged to widen the slot to a clear width of four feet and fit it with new shutter doors. Restoration of the building was completed with modern electric wiring, a new paint job within, and aluminum-painted heavy iron window and door guards without. The dome renovation was financed from another year's budget.

The new shutter doors provide the principal feature of our "new look" which is visible from the outside, and to us they are the outward symbol of other progress that has been made and of aspirations yet to be fully realized. Of the former we may mention that in the past two years our main building has also had a new paint job throughout, and completely new and modern electric wiring with fluorescent fixtures and ample outlets for auxiliary apparatus; a roomy darkroom has been provided and outfitted; a photoelectric photometer, utilizing a 1P21 multiplier tube, has

been built, paid for, and is now in service on the 20-inch refractor.

The Walton and Glover installation was hurried to completion that it might be ready for a class in advanced practical astronomy taught by the author in the fall of 1948. Very convenient was the appearance of Comet 1948l just as the class was ready to learn how to reduce the position of a body from astronomical photographs. The Schmidt camera had its baptism, insofar as our institution was concerned, with this comet.

A closeup of the Walton-Glover installation, showing the fork, the cradle, the three main instruments, the finder, and the declination slow motion.

We are not satisfied to use the new instruments only as part of our public enlightenment program, or even this plus student training in our astronomy courses at the university. Useful research will be done in whatever time we can spare from our rather considerable teaching duties. A photometric program of work on eclipsing binary stars is just taking form and will be pursued by the author with the help of assistants Arthur H. Williams and Nancy Mossman Iona. Assistants Mearl Carson and John Moore are photographing asteroids with the Schmidt camera, but are faced with a serious identification problem, for no blink microscope or other optical device to pick up the little travelers has yet been completed. When this shortage has been met we expect to be of some help to Dr. Paul Herget, of the Cincinnati Observatory, as he directs the international asteroid program.

Continuing research programs of the observatory are the observation and partial reduction of occultations of stars by the moon. This program is under the general supervision of the author but, of late, assistant Claude F. Knuckles has been doing most of the hard work. Dr. Recht continues his attention to the motion of Comet D'Arrest, and has recently published predicted positions for its next apparition in June, 1950.

A service of considerable importance is that of the entertainment of public and special groups. A large part of Dr. Recht's time has been devoted to this since he assumed the directorship of the observatory in 1926. In 1929 he started keeping an accurate tally of all visitors, and on November 16, 1949, the 50,000th passed through our door. She was nine-year-old Susan Wyman, of the Park Hill Elementary School in Denver. In honor of the occasion little Miss Wyman was, amid flashing photographers' bulbs and clicking shutters, offered the choice of a 3½-inch Skyscope reflector or a two-volume edition of the famous astronomy book, ***Splendour of the Heavens***. You're right! After due deliberation, Susan chose the telescope.

The author at the eyepiece of the photoelectric photometer attached to the Chamberlin 20-inch refractor. Photos on this page by C. F. Knuckles.

It is estimated that from 1894, when Chamberlin Observatory was opened, until 1929 probably another 50,000 visitors were taken care of, principally by the first director, Dean Herbert A. Howe. This important enlightenment program will continue, but it may have to be curtailed somewhat as the research program grows.

NEREID

"The Nereids were sea nymphs who, together with the Tritons, were the attendants of Neptune." That is why it is appropriate that the second satellite of Neptune, discovered by Dr. G. P. Kuiper, of the Yerkes and McDonald Observatories, should be given this name. Nereid is about six magnitudes fainter than Triton, the first satellite. In describing the discovery in the ***Publications*** of the Astronomical Society of the Pacific for August, 1949, Dr. Kuiper states that we would therefore expect Nereid to be about 1/16 the diameter of Triton, or about 300 kilometers.

Nereid is some eight or nine million kilometers distant from its parent planet, and as Neptune is considered able to hold moons at distances nearly 10 times as great, Dr. Kuiper plans additional searches for more distant objects in the Neptunian system.

Telescope users will be interested to know that the 40-minute exposures with the 82-inch McDonald reflector on May 1, 1949, on which Nereid was discovered, were made with the mirror diaphragmed down to 66 inches (f/5) in order to increase the size of the usable field. The field free from serious coma was about three inches in diameter, with the limiting magnitude at the center about 20 or possibly slightly fainter.

SPACE EXPLORER

Ordnance, November - December issue, reports that the Armour Research Foundation of the Illinois Institute of Technology is developing a new device to help discover the kinds of things a man needs to know if he is thinking of an eventual trip to the moon.

"A metal sphere containing heat-measuring equipment, a camera to record readings from the equipment, and gyroscopes to stabilize the flight of the sphere will be hurled from a high-speed rocket at an altitude in the neighborhood of seventy miles. . . . A radio transmitter on the camera will help in tracking the flight to earth when the sphere drops, and a parachute device is planned to enable scientists to recover the valuable film record made by the camera."

1,800 THUNDERSTORMS

It takes 1,800 thunderstorms in progress at any moment to help the earth's electrical field keep up its negative charge, according to Dr. Robert E. Holzer, professor of geophysics at the University of California at Los Angeles, as quoted by Science Service. He thinks of the sun as a giant generator, thunderstorms as batteries, and the earth and ionosphere as a colossal condenser. The greatest number of thunderstorms occur when it is afternoon over such land areas as South America and Africa. At those times the earth's charge has been found to be a maximum.

INDIA HONORS SCIENTISTS

The National Institute of Sciences of India, a nongovernmental group comparable with our National Academy of Sciences, has recently elected four foreign honorary fellows. They are Harlow Shapley, of Harvard Observatory; the French physicist, Louis de Broglie; the Swedish chemist, Hans Van Euler; and the German botanist, George Tishler.

NEWS NOTES

BY DORRIT HOFFLEIT

HOW BIG IS NEPTUNE?

Dr. G. P. Kuiper, of Yerkes and McDonald Observatories, has made a recent redetermination of the diameter of Neptune. Most of the older values had been based on micrometer measurements, whereby the separation of two fine spider threads was measured when they were set just tangent to opposite sides of the planet's disk-like image. By means of experiments with the 82-inch reflector, Dr. Kuiper concluded that such micrometer measures on small disks are far less trustworthy than measures made by matching the planetary image to an artificial disk whose size, brightness, and color could be varied at will; or by a double-image micrometer in which two images of the planet are brought into contact.

Employing principally the first method, and observing in March, 1948, and February, 1949, he found the planet to have an average apparent diameter of 2.044 seconds of arc, with a mean error of 0.016 second.

An adopted value of 2".04 gives the diameter of Neptune as 44,600 kilometers or 27,700 miles, according to Dr. Kuiper, with the mean error 400 kilometers or about 250 miles. The diameter of Neptune is thus almost exactly 3½ times that of the earth.

This is appreciably smaller than the figure near 31,000 miles found in most textbook lists, and causes a significant increase in the density calculated for the eighth planet, which now becomes 2.22 instead of about 1.6. About this Dr. Kuiper says, "The correction to the density is large and appreciably increases the diversity among the Jovian planets."

Recently, A. Shatzel determined photoelectrically the photovisual magnitude of Neptune as 7.95 at the planet's mean opposition, 3/10 of a magnitude fainter than previously assumed.

EVOLUTION OF THE EARTH

Dr. Harold C. Urey, of the University of Chicago, has a theory of the origin and evolution of the earth which reverses the usual belief that our planet was formed as a hot body. Two billion years ago, he believes, the earth was cool — a huge aggregate of dust containing all the known chemicals including the radioactive ones. The radioactivity has resulted in a gradual increase in the earth's temperature, but a more decisive source of heat in the earth's geologic history has been the release of gravitational energy by the flowing and sinking of iron through the outer portions of the earth to form its present irony core. The heat released has led to convection in the earth's crust to cause mountain building.

The Chicago scientist suggests that the difference in density between the moon and the earth may be explained if material of low density condensed to form the earth and moon first and heavier material (iron) condensed later. The original earth would therefore have had a core of "moonlike" material surrounded by a layer of silicates and iron. If this central core remained at the center of the earth for some time, and rose to the surface when displaced by the sinking iron, it may have produced the Pacific Basin with its floor of basaltic rock.

Time magazine reports that Dr. Urey pictured the early earth as covered entirely by water, in which life evolved a billion and a half years ago. The eventual rising of the core material produced a bulge in the outer layers to form a continent which then split into those we know on the earth's surface today.

RED-DWARF FLARE

Gerald and Katherine Kron, of the Lick Observatory, were observing the star BD + 20°2465 photoelectrically as a relatively bright example of a probable *single* dwarf *M*e star, in order to obtain comparative data for the interpretation of peculiar variations in the eclipsing double star YY Geminorum. They expected to find only small night-to-night variations caused by changes in the earth's atmosphere. On April 30th, however, while making routine observations in green light (at wave length 5200 angstroms), they found that rapid changes in the star's brightness had occurred within as short a space as nine minutes. In the *Publications* of the Astronomical Society of the Pacific they give the light curve and their interpretation of the phenomenon.

A sharp rise in intensity, amounting to at least 4/10 magnitude, was accomplished within six minutes. The sudden rise, the Krons believe, "was caused by a rapid release of energy in a small portion of the surface of the star." BD + 20°2465 had not previously been known to be a variable star.

OPEN CLUSTER DISTANCES AND VELOCITIES

Dr. Roscoe F. Sanford, recently retired from Mount Wilson Observatory, has derived new values for the distances of some 31 open star clusters. Their average distance is reduced about one fourth from a previous average of about 5,200 light-years. As starlight reaches us from such considerable distances, interstellar atoms, such as calcium, produce absorption lines in a star's spectrum that usually increase in intensity in proportion to the star's distance. By averaging measures of interstellar calcium lines in the individual stars of each cluster, Dr. Sanford was able to get rather accurate values of the distances of the clusters.

METEORIC DUST?

As a by-product of studies of mass movements in the atmosphere, two scientists at the New Mexico School of Mines, W. D. Crozier and Ben K. Seely, are investigating cosmic dust in the air. If tests of the particles found show iron, nickel, and cobalt, the dust particles are probably of meteoric origin.

NEW LAYER IN ATMOSPHERE

Early in November, it was announced that Dr. Joseph Kaplan, University of California at Los Angeles, had discovered a hitherto unknown layer of oxygen molecules in metastable energy states in the earth's atmosphere. The location of the layer is undetermined, but is believed to be just below the ionospheric E layer and just above the ozone layer, probably about 60 miles above the earth's surface. It is expected that this layer may provide some of the ultraviolet absorption previously attributed to the ozone.

Several years ago Dr. Kaplan first found, in gases excited by electrical discharge in the laboratory, a new form of nitrogen molecule. Recently a similar form of oxygen was produced, and Dr. Kaplan reasoned that conditions in the upper atmosphere should duplicate those under which the metastable molecules were produced in the laboratory. Current spectroscopic studies of the upper atmosphere by Dr. A. B. Meinel, at Lick Observatory, seem to verify Dr. Kaplan's prediction. The new layer is thought to transform ultraviolet solar energy into radiation of infrared wave lengths.

In the CURRENT JOURNALS

COSMIC RAY MEASUREMENTS IN ROCKETS, by Gilbert J. Perlow, *The Scientific Monthly*, December, 1949. "The physicist who desires to do cosmic ray experimentation with rockets must count on relatively short times of flight and a number of engineering problems foreign to his previous experience. On the other hand, the method holds promise of considerable reward."

THE INTERIOR OF THE SUN, by Martin Schwarzschild, *Leaflet* 248, Astronomical Society of the Pacific. "The center of the sun lies over four hundred thousand miles below its visible surface. No light ray can come directly from the core of the sun to us. . . . What are the facts on which we can base a theory of the solar interior?"

THE ENERGY OF THE STARS, by R. d'E. Atkinson, the Halley lecture for 1949, *Observatory*, October, 1949. What makes the stars shine? "The problem . . . is to find a source of energy which can suffice to keep the Sun shining at its present rate for at least 3000 million years. . . . "

Progress in Radio Astronomy - II

By Otto Struve, *Yerkes and McDonald Observatories*

RADIO STARS, as stated last month, do not show appreciable concentration toward the Milky Way. In fact, Ryle is of the opinion that in distribution with respect to brightness (in the radio waves) as well as in their distribution over the sky, they bear a distinct resemblance to the optically bright stars of our galaxy. But the two types of object are not identical. As far as we know, not a single star of the 1st or 2nd magnitude contributes appreciably to the illumination of the heavens in the range of radio waves. Experiments made at Cambridge by Ryle and others have shown that these point sources have annual parallaxes smaller than a few minutes of arc. They are thus probably not members of the solar system. But their lack of galactic concentration suggests that they are relatively nearby objects. Whether they are stars or concentrations in a diffuse medium has not been definitely decided.

A few years ago most radio technicians and astronomers were inclined to accept the view, first proposed by Reber and later rigorously developed by Greenstein, Henyey, and Keenan, that free electrons in interstellar space produce a kind of thermal radiation in consequence of their accelerations in the event of a close approach to a proton or another heavy particle. Such free-free transitions do in fact lead to a distribution of radiant energy which is not wholly different from that observed in the radio spectrum of the night sky. But Unsöld has recently produced convincing evidence that the free-free transitions cannot account for the small sources which we have described as radio stars. He has, for example, pointed out that according to the older hypothesis the distribution of radio waves should bear a marked resemblance to the distribution of the hydrogen emission regions which C. T. Elvey and the writer discovered at the McDonald Observatory about 10 years ago. No such correlation exists. Moreover, Unsöld argues that the interstellar medium has a much greater concentration toward the central plane of the galaxy than the radio radiation. There are also serious discrepancies in the distribution of the radiant energy with frequency. Apparently the same view has also been recently adopted by Ryle and Smith.

At any rate, Unsöld now believes that we must look for some unusual kind of star, probably of low luminosity and relatively low temperature, but possessing disturbed regions comparable to the solar flares and covering large portions of the surfaces of these stars. It must be remembered that the early rejection of stars as the originators of the cosmic noise was based almost entirely upon the conclusion of Henyey and Keenan that the quiescent sun is relatively very inactive in the radio waves. Unsöld has made a computation based upon a direct comparison of the surface brightnesses of the Milky Way and the sun, in the visual region and in the region of the radio waves. He concluded that the ratio is by a factor of about 10^{10} in favor of the Milky Way, but he believes that the sun is an exceptionally weak radio transmitting station, while the starlike objects are enormously more powerful, although they may be quite inconspicuous as visual objects.

As a tentative suggestion, Unsöld calls attention to the stars of Baade's Population II, especially those which belong to spectral types *K* and *M* and have strong emission lines of ionized calcium. The concentration of luminosity in Sagittarius might be an indication that stars belonging to the nucleus of our galaxy may be responsible for the large radio emission. Moreover, the Magellanic Clouds consist mostly of stars of Population I and are not known to show conspicuous emission of radio waves. Another possibility that has not yet been explored is that radio stars are related to H. W. Babcock's stars with large magnetic fields. Most of the latter are included in the group described by W. W. Morgan as metallic-line stars. Still another possibility is that they are close double stars with large prominence activity of the kind investigated by the author.

A totally different possibility was mentioned by J. G. Bolton, G. J. Stanley, and O. B. Slee. One of their radio objects in Taurus agrees in position with the Crab nebula (Fig. 3), an expanding shell of gas which Baade and Minkowski have attributed to the supernova of the year 1054. Minkowski has suggested that the surface temperature of the central star of the Crab nebula may be 500,000°, while the temperature of the nebula is about 50,000°. The radiation in the radio waves gives a temperature of two million degrees if the object has the angular size of the nebula. Hence, the agreement is not very good. In favor of Bolton's suggestion is the fact that another region discovered by him and his associates may well be identified with the nebula NGC 5128, which was previously regarded as an extragalactic object having a strong

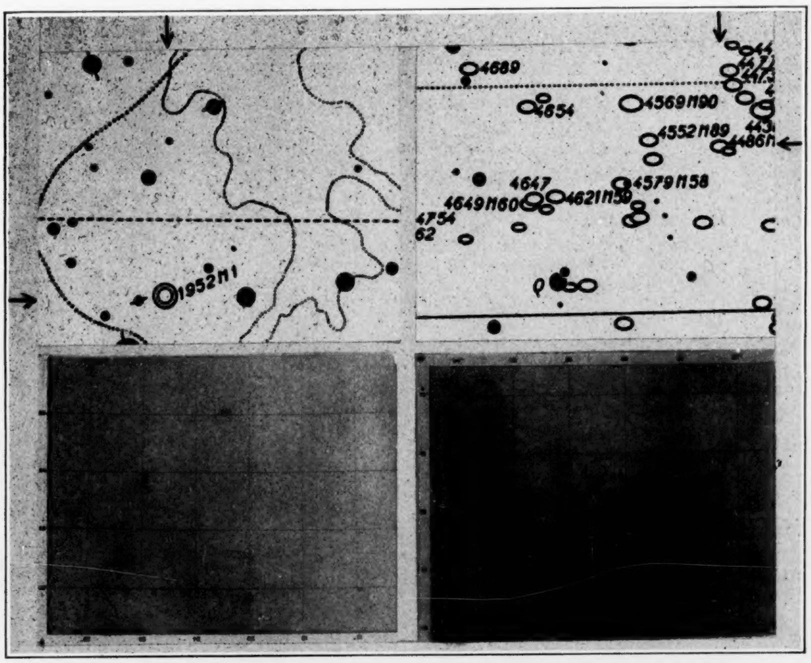


Fig. 3. Maps of two regions of the sky in which radio stars have been discovered. The upper charts are sections of the Skalnate Pleso "Atlas of the Heavens," showing not only the brighter stars but also the more important nebulae, clusters, novae, and variables. The same regions of the sky are shown below, taken from the photographic atlas by Wolf-Palisa. The arrows indicate the observed positions of the radio stars, one of them coincident with M1, the Crab nebula.

central obscuring band. However, recent work by D. S. Evans makes it appear almost certain that this object is in reality quite similar to the Crab nebula. (See News Notes, page 10, November issue.)

No such identifications can be made for the other well-observed radio stars, and perhaps it is best at the present time to accept Unsöld's view as a working hypothesis. Hence, we have prepared charts showing the positions of some of the best-determined radio stars.

Various authors have attempted to identify these objects with definite stars or nebulae. It is certain that they are not stars brighter than photographic magnitude 7. But it is entirely possible that a systematic study of the spectra of all the fainter stars might yield a definitive identification. In any event, astronomers will be expected to contribute this information because even a negative result would be important. Perhaps, as Kuiper has suggested, a search with a surface photometer having a lead-sulfide infrared-sensitive element would also be appropriate.

Unfortunately, it has not yet been possible to perfect radio telescopes to such an extent as to match the actual resolving power of the human eye or of a real optical telescope. This is due mainly to the great length of the radio waves. The angular aperture of a telescope, be it optical or of the radio type, is roughly determined by the ratio of the wave length to the aperture of the instrument. For example, if the radio wave length is 10 centimeters and the aperture of the telescope is 10 meters, then the angular resolving power is 1/100 radian or approximately half a degree. There have been two types of antenna built to remedy this difficulty. Reber plans to build larger and larger parabolic mirrors consisting either of sheet iron or a wire screen, by means of which the radio waves are reflected towards the focus of the instrument, at which he places a small dipole receiver having a length of about half a wave. This receiver is con-

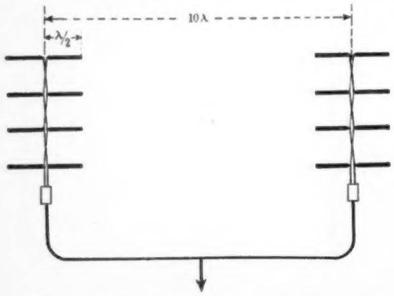


Fig. 4. Arrangement of dipole antennas used at Cambridge, England. These antennas are placed horizontally about two feet above the ground. Their purpose is to produce a diffraction pattern similar to that given by the Michelson interferometer in the optical region of the spectrum.

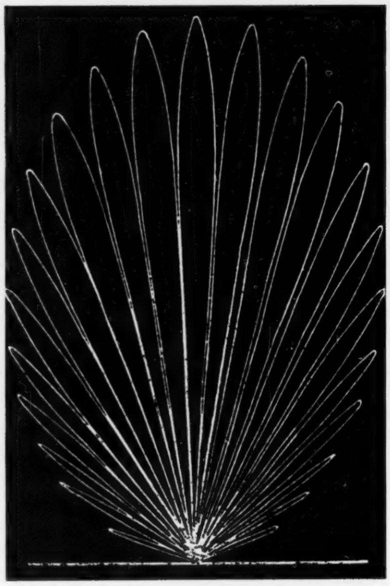


Fig. 5. The reception band obtained with an aerial such as in Fig. 4.

nected with an amplifying system analogous to a radio receiving set, and the output of the amplifier is recorded upon a tracing. A super-telescope 200 feet in diameter would give a resolving power of the order of about five or six minutes of arc, which is still much coarser than even a small photographic camera. An instrument of this type used in lunar eclipse observations is shown on the front cover.

A different arrangement discards the equatorially mounted parabolic mirror and consists of a series of horizontal wires, or dipoles, each half a radio wave long and enforced by a reflecting screen from behind. When two sets of antennas of this type are separated by a finite number of wave lengths the result is analogous to a Michelson interferometer. The schematic arrangement used by Ryle and his associates in Cambridge is shown in Fig. 4. The combination of several parallel dipoles with reflectors behind gives a reception band which resembles an ellipse, in the direction at right angles to the orientation of the dipoles. The resolving power of a single set of dipoles is limited by the width of the elliptical band, but the second set of dipoles acts in such a way as to produce interference with the signals received in the first set. The resulting reception pattern obtained with a separation of 10 wave lengths is shown in Fig. 5. If a point source of radio emission crosses the meridian in front of this composite antenna, the recording instrument shows a series of wiggles such as are reproduced in Fig. 6 with a separation of 140 wave lengths.

If the source is smaller than the resolving power of the instrument, which in the Cambridge setup is about six minutes of arc, the intensity drops to almost zero between successive lobes of the interference band of Fig. 5. If the emitting region is very much larger than six minutes, the band becomes completely smooth and the wiggles do not show at all. We observe only a gradual increase in intensity as the object passes over the meridian. If the region is intermediate in size, the individual wiggles are partly smoothed out, but this can be measured quite accurately by taking the ratio of the intensities at the top and at the bottom of each wiggle. The interference method has been successfully used by many observers in England and in Australia. It has given excellent results, but it must be remembered that the resolving power of these stationary antennas is greatest in right ascension and is relatively small in declination.

Astronomers are still wondering whether the precision of the positions of the radio stars is really as great as has sometimes been claimed. The recent results published by Bolton and his associates in *Nature* (July 16, 1949) differ greatly from those listed by Hey in his summarizing article in the *Monthly Notices* (Vol. 109, 194, 1949). Thus, the Taurus star was shifted 14 minutes in right ascension and six degrees in declination, while the angular width of the older determination was less than ½ degree and that of the newer determination was about seven minutes of arc.

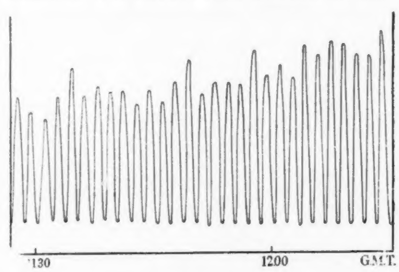


Fig. 6. A record obtained by Ryle and Vonberg at Cambridge with a spacing of 140 wave lengths in an aerial similar to that of Fig. 4.

SAMPLING THE UPPER ATMOSPHERE

"The atmosphere up to 230,000 feet has the same relative proportions of gases as at ground level." Thus *Science* summarizes an investigation utilizing V-2 and Aerobee rockets which the University of Michigan is carrying out as part of the U. S. Army Signal Corps program of investigation of meteorological phenomena at high altitudes. Particular interest centers on the relative concentration of helium at the earth's surface and at high altitudes. The gas analysis has been done by F. A. Paneth, of Durham University, England, who is investigating helium on a world-wide basis.

SEEING

By Dorrit Hoffleit
Harvard College Observatory

During the war years not only astronomers and pilots but also many people on military assignments became seriously concerned with the problems of seeing. Consequently, recent years have seen the publication of numerous papers on their investigations, especially in the *Journal* of the Optical Society of America. These have been concerned with the visibility of objects, particularly liminal and sighting ranges as functions of image contrast and atmospheric conditions. The majority deal with the detectability of a target, and less with the steadiness of the image, or what we ordinarily call "astronomical seeing."

Planetary observers have made us particularly aware of seeing problems by the futility they experience in trying to obtain photographic confirmation of the fine detail they have observed visually — observations made in rare moments of exceptional seeing in literally hours of careful watching.

What constitutes good seeing? Nearly all observers record seeing on some purely arbitrary scale, indicating the overall haziness of the appearance of the sky, the cloudiness, perhaps the limiting visual stellar magnitude. Those who peer through guiding telescopes may measure atmospheric steadiness by the relative difficulty in keeping a guide star on the crosshairs. To be meaningful, these notes on seeing must be made by an experienced observer. Even so, his scale may differ appreciably from that of any other skillful observer.

Dr. Enrique Gaviola, of the National Astronomical Observatory at Cordoba, Argentina, has made an excellent beginning in the evaluation of photographic seeing in the June, 1949, issue of the *Astronomical Journal*. The 60-inch reflector at the Bosque Alegre station, for light of 0.00004-centimeter wave length, should give stellar images having diameters of 0.13 second of arc under perfect seeing conditions.[1] Actually, however, the *sharpest* images recorded were several times larger than the theoretically expected values while the average diameters were 15 to 23 times larger.

To experts in positional astronomy this should not be surprising. Many years ago America's "father of astrometry," the late Frank Schlesinger, director of the Yale Observatory, had indicated in classical contributions[2] that diameters in excess of a second of arc should be the rule rather than the exception. Fig. 1 represents schematically the meanderings of a star image on a photographic plate within a period of two or three seconds. The track shows about three irregular loops with a diameter of several tenths of a second of arc. At each of the three observatories, Allegheny, Yale, and Mount Wilson, Dr. Schlesinger found from star trails that all the star images in a small area of the sky (a "parallax field") have parallel motions (Fig. 2). He found that, in addition to the more rapid small fluctuations, the star images wandered from their mean positions even during good seeing, in periods of about a minute and with deviations of about one second of arc.

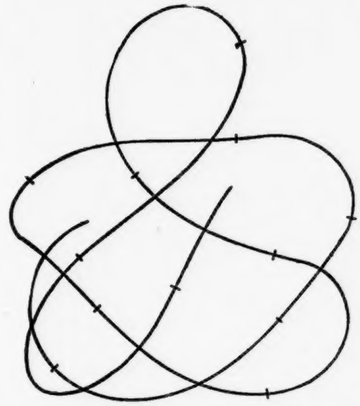


Fig. 1. The wanderings of a star's image during perhaps two or three seconds. According to Frank Schlesinger, this results chiefly because of unsteadiness of the image even when the seeing is good. The short marks are at the places that are recorded on the plate when a sector with an opening of 36 degrees is employed.

Schlesinger had been surprised that his early photographic measurements of the positions of parallax stars relative to their faint neighbors were much more accurate than measures by highly experienced visual observers. This resulted from the parallelism of the motions and the fact that all the stars on a plate are photographed exactly at the same time, whereas visually an observer cannot make settings of his crosshairs on two stars simultaneously.

In planetary observation, on the contrary, it is the absolute motions of the image on the plate that are important, and they are always such as to blur the photograph. And the wartime observers may have been affected still differently. Suppose an enemy craft were sighted through "boiling" desert air, where all seeing effects are highly magnified over astronomical conditions. If the instantaneous fix on the image were wrong by say one minute of arc, would the gunner have hit his target? There are many angles to the problem of seeing and its applications.

Another aspect that Schlesinger discussed was the refraction of our atmosphere as a whole. He showed that all stellar images should be short spectra, vertical with the blue end nearer the zenith. For yellow-blue light he found that the lengths of the spectra increase with the star's distance from the zenith in the following manner:

Zenith distance	0°	15°	30°	45°	60°	75°
Vertical length of star image in seconds of arc	0	0.2	0.5	0.8	1.4	3.0

Since some stars are red and others white or blue, further complexities arise. It is possible, because of atmospheric refraction, for the effective measured positions of *M*-type stars to be displaced by as much as ¼ second of arc relative to *A*-type stars, depending on the declination and hour angle of the field.

Schlesinger's early work thus indicated that atmospheric effects could introduce both meanderings of the image and dispersion (of the colors) that would account for image diameters in excess of a second of arc in any part of the sky, and in excess of three seconds of arc at low altitudes above the horizon.

What, then, does Gaviola add? He looks for greater detail, both in the time fluctuations and in the complexities of

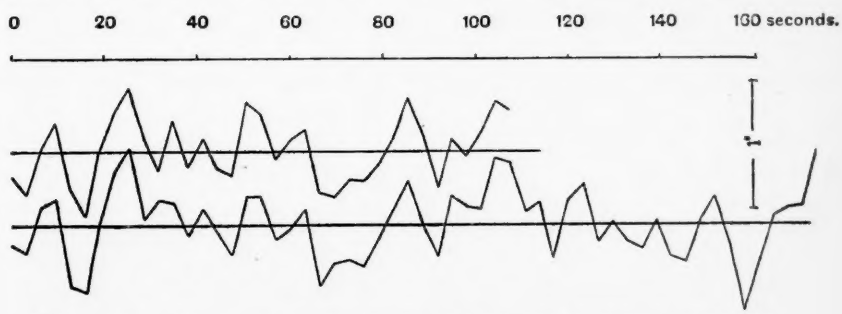


Fig. 2. Plots of trails of two stars in the Pleiades, Merope (upper curve) and Alcyone, which are about 20 minutes of arc apart in the sky, measured from the same plate by Schlesinger. Points corresponding in time are on the same vertical line. The vertical scale shows in seconds of arc the displacements of the trails from their mean positions. Small differences in the two paths are attributed to errors in measurement.

[1] If the diameter of the objective or mirror of the telescope is D, and the wave length of light λ, then diffraction theory gives the diameter of the stellar image as $500{,}000\ \lambda/D$.

[2] *Seeliger Festschrift*, 1924; Darwin Lecture, 1927.

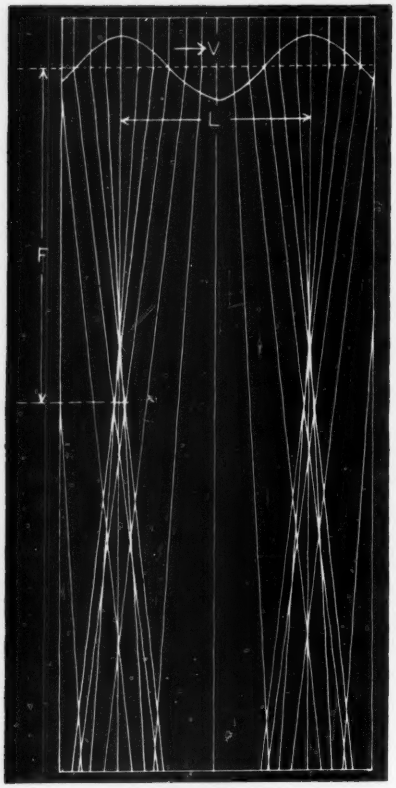


Fig. 3. Enrique Gaviola's representation of the manner in which moving waves at an inversion layer in the atmosphere above the observer cause refraction of parallel beams of starlight to produce the effects of seeing known as dancing, pulsation, and scintillation. The vertical scale is reduced some 1,000 times compared to the horizontal scale. Diagram courtesy "The Astronomical Journal."

the atmosphere; and he proposes means for checking seeing conditions by quantitative observations. He is concerned chiefly with the effects on starlight of the well-known phenomenon of meteorology known as a temperature inversion. Often, at one or more levels in the atmosphere, a warmer layer of air lies above a colder layer. Motion of either layer relative to the other can cause a system of waves or ripples at the interface that may be likened to the ripples in water at the beach. Think here of inversion surfaces thousands of feet up in the air and wave lengths (L in Fig. 3) a few centimeters or inches long.

Light from celestial bodies passing through such a wave-shaped surface between air layers of differing densities is refracted just as in a lens, producing several "focal points" and an average "focal length," labeled F in Fig. 3. As the deviation of each light ray is very small, F will be very long, perhaps even greater than H, the distance from the inversion layer to the telescope. The inversion wave is probably moving (velocity V), and this together with the aperture of the telescope (D) will determine how rapidly seeing changes are produced in the stellar image.

Dr. Gaviola points out the three main characteristics of seeing: *dancing,* change of position; *pulsation,* change of size; *scintillation,* change of intensity. He examines Fig. 3 critically to show how the different types of seeing effects depend on the relations among $D, L, H,$ and F. For instance, when D is small relative to L (a small telescope), then what is seen depends on the relation of H to F. If the inversion layer is relatively low (H much less than F), then there will be dancing of a fine image, and little or no scintillation. If H is much greater than F (high layer and small waves), the observer is located at the bottom of Fig. 3 and there should be large, steady images. But if H is near F, then the observer is located in the critical portions of Fig. 3, and scintillation and pulsation should be strong, bright and large images should appear simultaneously, and some dancing should occur.

For medium-sized instruments, in which D is between L and $L/2$, the position high in Fig. 3 will give little dancing of an enlarged image. For layer heights much greater than F, large, steady images will be seen, but in the critical region in which the "focal points" are at or near the telescope there should be large scintillation. In this case, however, the larger aperture will take in more rays and reduce the amount of pulsation and dancing.

Finally there is the case of the large telescope — with diameter at least as great as the wave length L. Its aperture will cover the entire wave system shown in Fig. 3 and may include many waves of about the same length. Moreover, if more than one inversion layer is present in the upper air, several such wave systems may even be present at the same time. Each inversion layer wave system, if the waves are sufficiently regular, might be compared with an optical (transmission) diffraction grating. Hence Gaviola introduces the concept of "inversion layer spectra." The effects of these and his method of photographing such spectra in star images will be considered in further notes on seeing next month.

The existence of inversion layers can be detected by an observer if he removes the eyepiece from his telescope and puts his eye just outside the focus. During fair seeing (one or few inversion layers present, with little turbulence) more-or-less rectilinear shadows will be seen moving perpendicular to their lengths. Dr. Gaviola has photographed the waves in the light of Sirius with a camera (75-mm. focal length) inside the Cassegrainian focus of the 60-inch reflector at Cordoba Observatory. The camera was focused on the primary mirror, and the exposures ranged from 1/10 to 1/100 second. Pictures 1 to 7 in Fig. 4 were taken in the light of Sirius on October 3, 1947, within a 40-minute period. Sirius' direct image consisted of two elliptical components, superimposed and having diameters of about three seconds of arc. The long axes of the ellipses were aligned in the same direction as the shadow bands seen on the mirror. The shadow bands photographed on the mirror (154-cm. diameter) gave values of L from five to 50 centimeters,[3] frequently with several wave systems showing simultaneously. An inversion layer of five centimeters wave length fully accounts for the three-second image diameter, but the images are blurred and increased in size by dancing and unsteadiness of the wave patterns. In order to get the minimum image diameter, exposures should be short compared with the period of vibration.

(*To be concluded*)

[3]If λ is the effective wave length of light (say 0.00004 cm.) and γ the angular separation of successive bands observed in the photographs, then the linear separation, L, of the waves in the atmosphere can be computed simply from $\lambda = L \sin \gamma$.

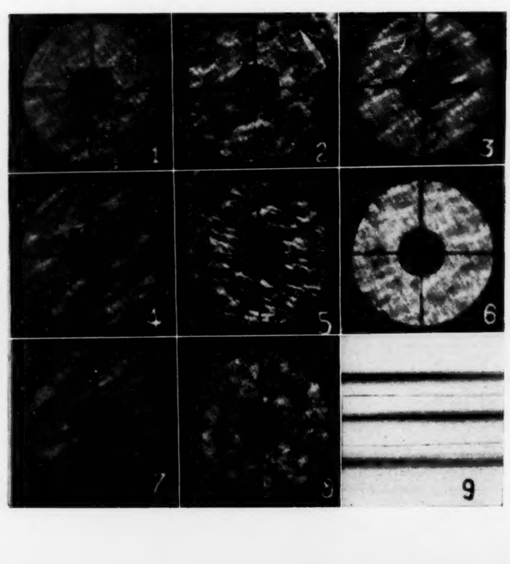


Fig. 4. Dr. Gaviola's photographs of inversion layer shadows of Sirius (1 to 7) and of Canopus (8), with the 60-inch Cordoba Observatory reflector. Fine structure (inversion layer spectra) in trails of Sirius are shown in 9. Engraving courtesy "The Astronomical Journal."

Four Independent Simultaneous Drawings of Ganymede

By Walter H. Haas, *Director, Association of Lunar and Planetary Observers*

DURING the recent convention of western amateur astronomers in Los Angeles, Calif.,[1] four members of the Association of Lunar and Planetary Observers had an opportunity to use the Griffith Observatory 12-inch Zeiss refractor. The instrument was made available through the courtesy of Dr. Dinsmore Alter, director of the observatory. On the evening of August 23, 1949 (local date) we began observations by directing the telescope at Jupiter. The image found was a truly excellent one, and eight dark belts were easily visible (north equatorial, south equatorial north and south components, south temperate, north temperate, north north temperate, south south temperate, and equatorial band[2]). In the south equatorial belt we saw a number of **tiny** dark spots considerably smaller than the disks of the satellites. Their diameters were probably only 0".3 or 0".4, and they were undoubtedly beyond the grasp of most telescopes of ordinary sizes. Since the view was so good, we turned our attention to Jupiter **III** or Ganymede and were pleasantly surprised to find markings on it that were almost easy. The writer had never before seen detail on the satellite so well, even with an 18-inch refractor.

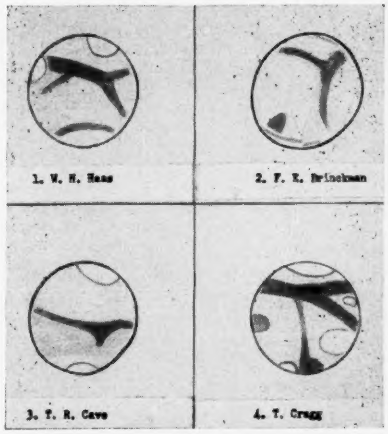
We then each made a drawing of the satellite, and these are reproduced in the accompanying picture. **They are completely independent;** no observer had any idea what the others had seen when he was at the telescope. The magnification employed was 555 times. The views shown are all simply inverted ones with south at the top and west at the left. The disk of Jupiter **III** was oriented by noting the direction of other satellites from it. The sky was clear. The seeing, or atmospheric steadiness, was noted on a scale of 0 to 10 with 10 best. Data on the four drawings follow:

No.	*Observer*	*Time* (p.m. PST)	*Seeing*
1	Haas	11:25-11:37	4
2	Brinckman	11:50	4
3	Cave	11:52-11:58	4-6*
4	Cragg	12:00	6-7

*Seldom 4

General impressions of detail on the satellite are perhaps best summarized in Cragg's joking remark the next day: "We now call it Mars, Junior." Haas more formally noted while observing: "The resemblance to Mars when the central meridian of longitude is about 250° (Syrtis Major, Hellas, polar caps, etc.) is indeed **striking** at times."

Every observer but Brinckman saw white caps near both the top and the bottom of the disk. These may be regarded as north and south polar caps; for variations in the brightness of Ganymede have a period equal to the period of its revolution around Jupiter,[3] and this result has been interpreted to mean that the satellite always keeps the same face toward its primary. Its axis of rotation must hence be very nearly perpendicular to the plane



Drawings of Jupiter's third satellite, Ganymede, made independently with the Griffith Observatory Zeiss refractor.

of its orbit, and the white areas must be near the geographic poles. Haas thought the south cap much brighter than the north cap, but the others do not confirm this difference. It will be seen that Cave and Haas drew the polar caps not diametrically opposite each other; one may wonder whether there is an analogy to the similar aspect sometimes found on Mars when one of its polar caps is atmospheric.

Three of the observers agree surprisingly well that the most conspicuous dark markings took the form of a large, near-horizontal Y and that the two arms of this Y met its base in the upper right (southeast) quadrant of the disk. In fact, the Y is evidently imperfectly shown on Cave's drawing too, though the junction point is there in the lower half of the disk. It appears probable that a dark feature drawn by Brinckman near the north limb and suggestive of the Mare Acidalium on Mars is also present on Cragg's drawing. The greater amount of detail on Cragg's drawing than on the others may be due to the better seeing when he was at the telescope.

In the past a number of observers have thought Jupiter **III** to be at least at times slightly elliptical rather than round.[4] This aspect has been attributed by some persons to imperfectly seen bright and/or dark markings near the edge of the disk. On this occasion both Brinckman and Cave thought the satellite elliptical, with the major axis lying in approximately a south-southeast to north-northwest direction. Haas obtained an **impression** that the satellite was elongated roughly north-south but unfortunately did not record any notes on this appearance before talking with the others.

On August 23, 1949, the polar radius of Jupiter was 21".5.[5] If we take its linear polar diameter to be 83,000 miles and the linear diameter of the satellite to be 3,100 miles,[6] then the angular diameter of Ganymede can be computed to be 1".6 at the time of the observations. The satellite was about 16 hours past superior geocentric conjunction.[7]

It is, of course, nothing new to see markings on Jupiter **III.** Among the many persons who have observed detail here are Dawes, Lassell, Secchi, W. H. Pickering, Barnard, Antoniadi, Flammarion, Jarry-Desloges, Douglass, and the Pic du Midi workers.[3,4,6,8] It was interesting to find that Secchi "described **III** as similar in aspect to the mottled disk of Mars as seen in a small telescope,"[8] in curiously close agreement here with our four observers.

Some of the best-equipped members of the Association of Lunar and Planetary Observers are making careful studies of the Jovian satellites on occasional nights of excellent seeing. The headquarters of the association are at the University of New Mexico, Albuquerque, N. M. For this particular observational study, it is usually necessary to have at least 8 or 10 inches of aperture, and the instrument must be of **excellent** optical quality.

Institute of Meteoritics
University of New Mexico
Albuquerque, N. M.

This paper was read at the October, 1949, meeting of the American Association of Variable Star Observers.

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[3]E. Pfannenschmidt, "Beobachtungen der Planeten. Jupitermond III," **Sternenwelt, 1,** 8, 185, 1949.

[4]Ed Martz, Jr., "Planetary Report No. 11. Jupiter's Third Satellite," **Amateur Astronomy, 2,** 7, 82, 1936.

[5]**The American Ephemeris and Nautical Almanac** for 1949, page 208.

[6]"French Astronomy During the War Years," **Sky and Telescope, 4,** 9, 3, 1945.

[7]**The American Ephemeris and Nautical Almanac** for 1949, page 420.

[8]W. F. Denning, **Telescopic Work for Starlight Evenings,** page 193, 1891.

AMATEURS ACTIVE AT WILSON, NORTH CAROLINA

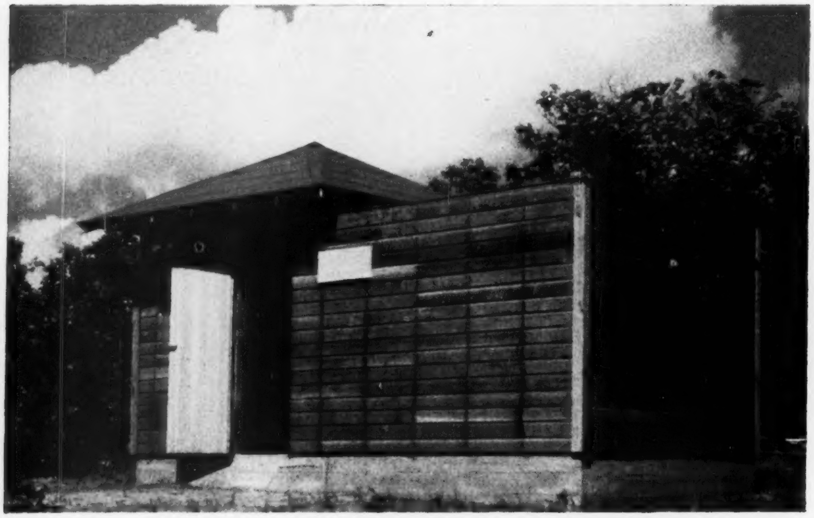
Astronomy has been a particular hobby with me for many years, and it is a double pleasure for the reason that my wife is as greatly interested. We spend many enjoyable hours in meteor observing, searching out clusters and nebulae, hunting for doubles, and at times the nights pass only too fast.

Wilson is a town of more than 25,000, and from all that I can learn, Mrs. Eason and I until 1948 were the only two amateurs in the city. Now we have nine members in the American Meteor Society, and numerous others who make observations. We have secured two observers in Greenville, and one each in Wilmington, Apex, and Salisbury. We have groups that visit us at intervals for star parties, and we now have the Atlantic Christian College science club interested.

Incidentally, astronomy is gaining greater interest in this state since the Morehead Planetarium has been in operation.

F. B. EASON
504 W. Vance St.
Wilson, N. C.

Amateur Astronomers



Camp Shin-Go-Beek's new observatory, with the roof of the instrument room rolled back, showing the telescope pointing over the west wall.

A Scout Camp Gets a Working Observatory

At Camp Shin-Go-Beek, near Wild Rose, Wis., 450 to 500 boy scouts and their leaders from the western suburbs of Chicago now have the opportunity, during the summer camping season, to examine at close range many wonders of the sky.

The telescope, a Mellish 5½-inch equatorially mounted refractor, formerly owned and operated by scouts of Troop 16 in their observatory at the First Presbyterian Church of Oak Park, Ill., was presented by this troop to the Thatcher Woods Area Council, B.S.A., Oak Park, early in 1949 for use at the new 500-acre camp in north-central Wisconsin.

With the gift of the telescope was included a simple but complete building consisting of an instrument room and a workroom. Over the instrument room, which is 10 feet square, is a peaked roof mounted on wheels so as to roll northward over the shed roof of the workroom. The entire floor is a heavy concrete slab, into which the steel pier is deeply embedded.

On the walls of the instrument room there are hung a giant blueprint star chart, with a grid of one inch equal to five degrees, a converted eight-day clock with a 24-hour dial showing sidereal time, a number of large pictures of interesting objects, and a blackboard for notes and diagrams of current observations. Switches for all lighting and for the Telechron driving motor are conveniently located on the pier, the power being brought in underground from a pole located out of instrument range.

The workroom through which the observatory is entered is also 10 feet square, and is provided with a study table, bookshelves, a steel locker, and two bunks hung one above the other on the wall. Here the counselor may catch up on a nap now and then, and he or the night watch can turn in after a late class without disturbing others in the camp.

Soon after the little observatory was opened, it was apparent that the study made possible would become a successful addition to the camp program. Not only were most of the boys interested in the general demonstration and the opportunity to look through a telescope (a great many for the first time), but a surprisingly large number asked for more astronomy at the sacrifice of other opportunities. Before the season closed it had been demonstrated without doubt that the project had been well received, and that these scouts would go home with a much better understanding of the sky than they had ever had before.

Every one who has had a part in bringing this project to completion is gratified, not only with immediate results, but also with the report of the national camp examiner, who says that Camp Shin-Go-Beek is the most completely equipped boy scout camp in the United States for the study of astronomy. It is reasonable to expect that this observatory will inspire boys to a better study of the heavens for many years to come.

W. M. GRAHAM
1011 Lake St., Oak Park, Ill.

BLACK RIVER ASTRONOMICAL SOCIETY

Lorain County, Ohio, has a new astronomical society, whose first organization meeting was held on October 7, 1949. Under the guidance of L. E. Armfield, one of the founders of the Milwaukee Astronomical Society, the society was formed "to promote the study of astronomy and allied sciences and to foster a public interest in astronomical subjects; give and sponsor public lectures; subscribe for and publish literature calculated and intended to diffuse information regarding astronomy and astronomical discoveries; purchase, lease and otherwise acquire real estate for the purpose of erecting one or more astronomical observatories and all necessary auxiliaries thereto; conduct astronomical researches; co-operate with other educational institutions; conduct private meetings and public forums for scientific study and discussions; receive and accept gifts of land, goods, funds and materials in order to advance the general purpose of the society, and to foster a spirit of fellowship among the members."

Active membership dues have been set at five dollars per year, and junior membership for persons under 21 at two dollars per year. Mr. Armfield is the first president; W. A. Mason, vice-president; Louis Rick, secretary; and William C. Roe, treasurer. Meetings are planned for the second Monday of each month in the Clearview School at Penfield Junction.

The society is publishing a monthly mimeographed bulletin, from which the above information has been taken, under the editorship of Walter Evans, Jr.

W. M. Graham, a scoutmaster for 33 years and designer of the project, gives two eager scouts their first demonstration of sunspot projection.

THIS MONTH'S MEETINGS

Cambridge, Mass.: On January 5th, at Harvard Observatory at 8:15 p.m., the Bond Astronomical Club will hear Albert P. Linnell, of Amherst College Observatory, speak on "A Peculiar Variable Star."

Chicago, Ill.: At its meeting on Tuesday, January 10th, at the Chicago Academy of Sciences at 8:00 p.m., the Burnham Astronomical Society will have installation of 1950 officers and directors, followed by a talk on the January evening sky, and a symposium on telescopes, covering mirror making, testing, and mounting.

Columbus, Ohio: The Columbus Astronomical Society will meet on January 31st at Campbell Hall on the Ohio State University campus at 8 o'clock. Dr. Geoffrey Keller, of Perkins Observatory, will speak on "The Family Life of a Star." Preceding the main lecture, Scott Rose, graduate student at OSU, will give a 30-minute "Introduction to the Spectroscope."

Dallas, Tex.: "The Phenomena of Light Applied to Photography" will be the lecture by Henry Garcia at the January 24th meeting of the Texas Astronomical Society, 8:00 p.m. in the Texas Power and Light auditorium.

Detroit, Mich.: The January meeting of the Detroit Astronomical Society will be at State Hall, Wayne University campus, on Sunday afternoon, January 8th, at 3 o'clock. Following the annual business meeting and election of officers, William C. Nicholson will give a talk on "Astronomical Geology."

Geneva, Ill.: On Tuesday, January 3rd, Clarence R. Smith will discuss "The History and Use of Astronomy," at the meeting of the Fox Valley Astronomical Society, 8 o'clock in the Geneva City Hall.

New York, N. Y.: "The Structure of Giant Stars" will be the topic of Dr. Lloyd Motz, of Rutherfurd Observatory, at the January 4th meeting of the Amateur Astronomers Association, 8:00 p.m. in the American Museum of Natural History (77th St. entrance).

Stamford, Conn.: On January 20th the Stamford Amateur Astronomers will hear Dr. Charles P. Olivier, of Flower Observatory, speak on "The Solar System." The meeting is at the Stamford Museum at 8 p.m.

Washington, D. C.: Dr. Bart J. Bok, of Harvard College Observatory, will describe his forthcoming "Center of the Galaxy Expedition," at the January 14th meeting of the National Capital Astronomers. This is on the second Saturday of the month, at the Department of Commerce auditorium, 8:00 p.m.

Worcester, Mass.: Dr. Martha Stahr, of Cornell University, will speak on that institution's solar noise research program before the Aldrich Astronomical Society, on January 3rd, Tuesday, 7:30 p.m. at the Museum of Natural History.

SACRAMENTO SOCIETY TO PUBLISH ASTRONOMICAL INFORMATION SHEETS

The work of the late Professor G. Bruce Blair, of the University of Nevada, as editor and publisher of Astronomical Information Sheets for many years, will be carried on by the Sacramento Valley Astronomical Society. A panel of editors has been chosen: Leon Salanave, editor; Paul Steele and Carl Wells, associate editors; Elizabeth Champ, managing editor. Mrs. Champ is president of the society and editor of its monthly news bulletin. Those persons who have been receiving the News will receive a sample mailing of the new Astronomical Information Sheets, for which the subscription is $1.00 for 10 mailings. Subscriptions should be sent to Sacramento Valley Astronomical Society, Sacramento Junior College, Sacramento, Calif.

WORCESTER LECTURE SERIES

At the suggestion of Wayne C. Lovell, president of the Aldrich Astronomical Society, Edward C. Olsen and Fred A. Franklin were delegated to study and submit a series of lectures to be put on for the public. Our first lecture course has just closed, and from now on no year will pass without such a series if at all possible. We are planning a couple of observing nights for those who attended, and constellation study in the spring for them.

Perhaps other clubs would like to know our outline. There were six lectures: the history of astronomy; telescopes and accessories; the solar system out to the earth and moon; the outer solar system including meteors and comets; double and variable stars, the Milky Way, and outer systems; and finally, a lecture by Dr. Bart J. Bok, of Harvard Observatory, on a modern observatory in action.

Was it worth the trouble? We have had 45 outsiders at one meeting. One has joined, and others are talking about it; and we have gotten some experience in presenting astronomy to strangers. Most of the regular attenders took notes at every talk. Newspapers gave us space, and three radio stations announced the lectures.

RALPH A. WRIGHT, secretary
Aldrich Astronomical Society
4 Mason St., Worcester 2, Mass.

HERE AND THERE WITH AMATEURS

Five societies have been added to the regular listing of amateur astronomical groups under the above heading on page 65. The total number of organizations listed there is now 86, of which 41 are members of the Astronomical League and 39 include **Sky and Telescope** as a privilege of membership at the special group rate of $1.50 that applies when all members of a group receive the magazine.

There are two societies added to the listing in Ohio, at Akron and Lorain-Elyria, and in Texas, at Dallas and Ft. Worth. One society has been added to the Missouri groups. As we wish this listing to be as complete as possible, we shall be glad to receive information concerning other active societies, and also revisions from those presently listed. All information should be received by April 1st, for inclusion in the May issue, when Here and There with Amateurs next appears.

Planetarium Notes

BALTIMORE: ***Davis Planetarium.*** **Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.**

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evenings, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Director, Roy K. Marshall.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill. Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P.O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday and Thursday at 8:30 p.m. Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Curator, Gordon A. Atwater.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

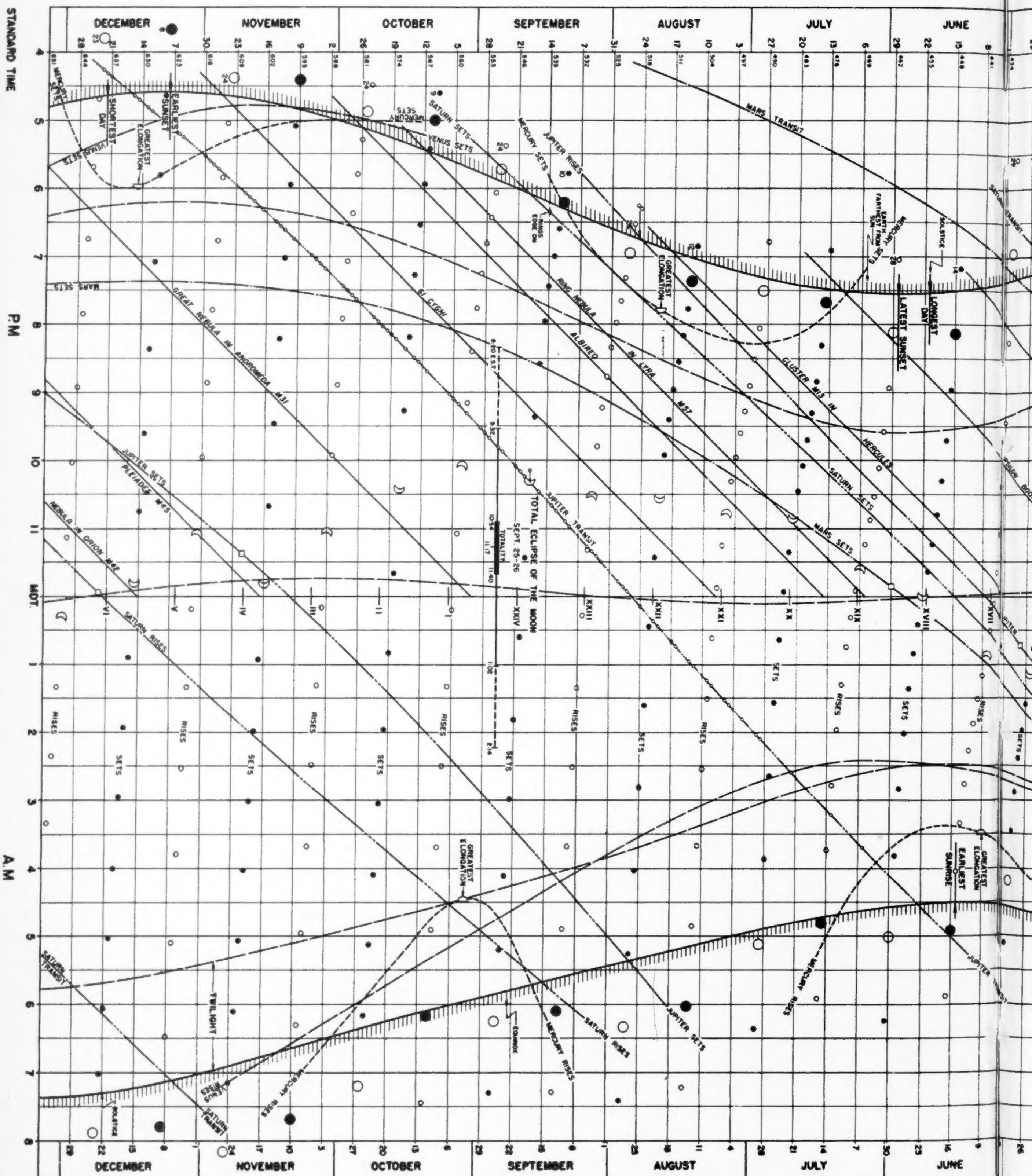
SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings as 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Tuesday and Sunday, 4 p.m. Special showings on request. Admission free. Spitz projector. Director, Robert E. Cox.

Graphic Time Table of

PREPARED BY THE MARYLAND



f the Heavens - - 1950

D ACADEMY OF SCIENCES

The Graphic Time Table of the Heavens

while still available may be secured without charge directly from the Maryland Academy of Sciences, Pratt Library Building, 400 Cathedral St., Baltimore 1, Md. Blueprints of the original drawing before reproduction are available at cost — 75c each — 40 x 27 inches. A Quebec edition, in French, for 47° N. and 75° W., is also available upon request.

The Graphic Time Table gives the rising and setting times of the sun, moon, and bright planets; the beginning of morning twilight and the ending of evening twilight; the times when certain stars and other objects of interest transit (cross the celestial meridian); phases of the moon; the equation of time; and other astronomical information. To illustrate by an example: The events of the night of January 5-6 may be found by following the horizontal line for that date across the graph from left to right. The Julian Day number for that evening is 2,433,287. The sun sets at 4:48 p.m. standard time; the moon rises at 6:14 p.m.; Mercury sets at 6:15; evening twilight ends at 6:26; Jupiter sets at 6:36 and Venus at 7:36; the Pleiades transit at 8:44; Saturn rises at 10:00; the Great Nebula in Orion transits at 10:36; Mars rises at 11:12. The curve for the equation of time shows that the sun is slow and will not be on the meridian until six minutes after 12 o'clock noon, local time, January 6th. Saturn transits at 4:22 in the morning, and Mars at 5:16; morning twilight begins at 5:45 a.m., and the sun rises at 7:22 a.m.

The dashes on the sunset and sunrise curves aid interpolation on intermediate days. Roman numerals show sidereal time at midnight. The phases of the moon are indicated by the conventional symbols. Small black circles show moonset for the first half of the lunar month, and small open circles show moonrise from full to new moon. Circles on the Jupiter transit curve indicate nights on which occultations, eclipses, or transits of Jupiter's bright moons occur between 7:00 and 11:00 p.m. EST. Small squares on planet curves indicate quadrature, and oppositions are marked by the conventional symbol.

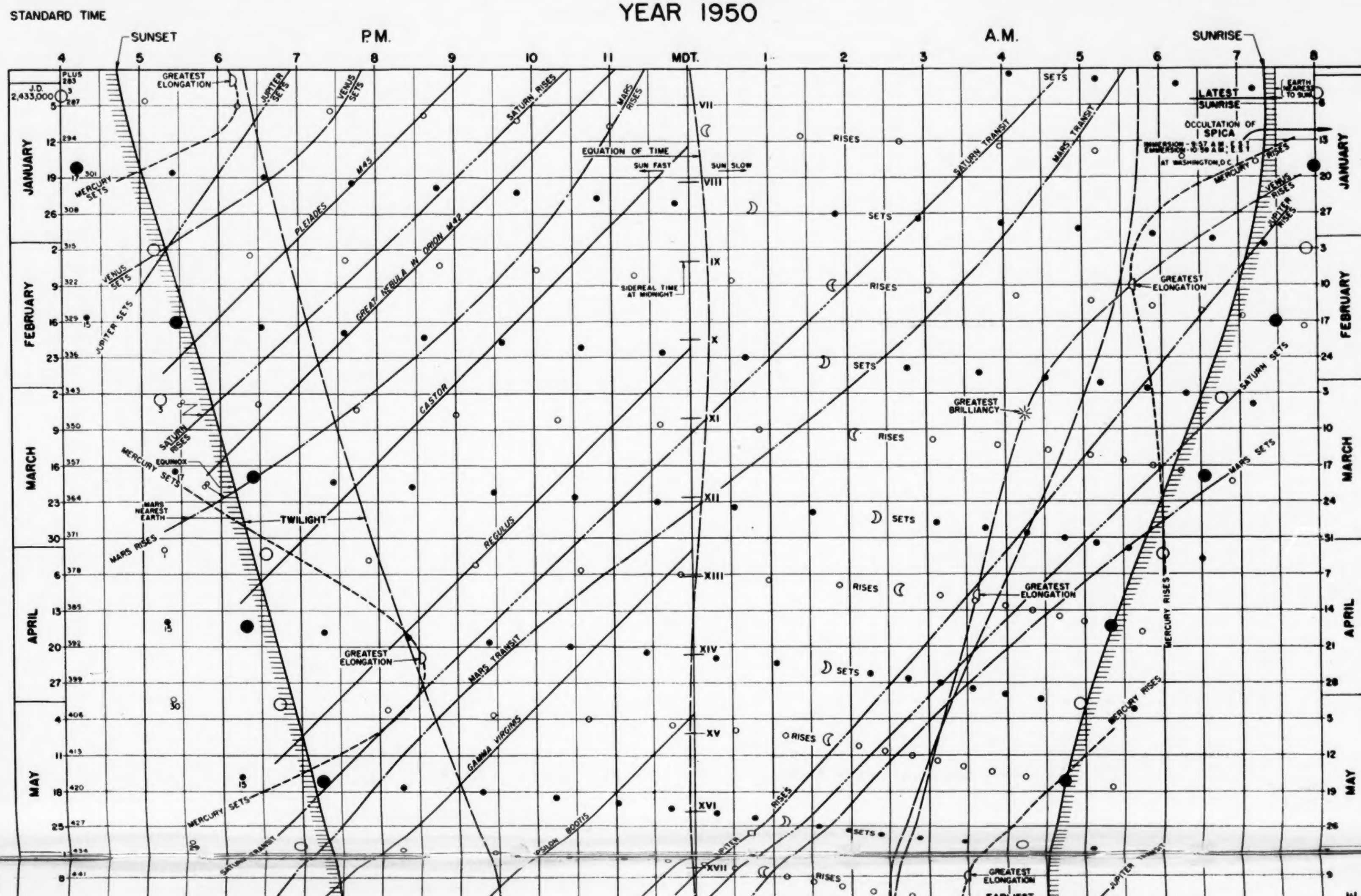
How to Correct for Your Position

As in all almanacs, times of rising and setting of sun, moon, and planets are absolutely correct for only one point on the earth's surface — for this chart: latitude 40° N. and longitude 90° W. The observer may easily correct for his own position. Latitude differences have comparatively minor effect and may in general be disregarded.

Correction for difference in longitude depends principally on the observer's distance east or west of his standard time meridian, which is always at an even multiple of 15°. Some corrections are tabulated here, in minutes of time:

Atlanta	+38	Detroit	+32	New York	— 4
Baltimore	+ 6	Houston	+22	Pittsburgh	+20
Boston	—16	Indianapolis	—16	Rochester	+10
Chicago	—10	Kansas City	+18	San Francisco	+10
Cincinnati	+38	Los Angeles	— 7	Seattle	+10
Cleveland	+27	Milwaukee	— 8	St. Louis	+ 1
Denver	0	Minneapolis	+13	Washington	+ 8

All places with plus correction are west of the standard meridian, and the events will occur later. The usual correction of one hour for each standard time zone must also be made to the Eastern standard times given for lunar eclipses and Jupiter's satellites, and in the Far West slight corrections may be made to times of moonrise and moonset. For times of occultations and solar eclipses, refer to the "American Ephemeris."



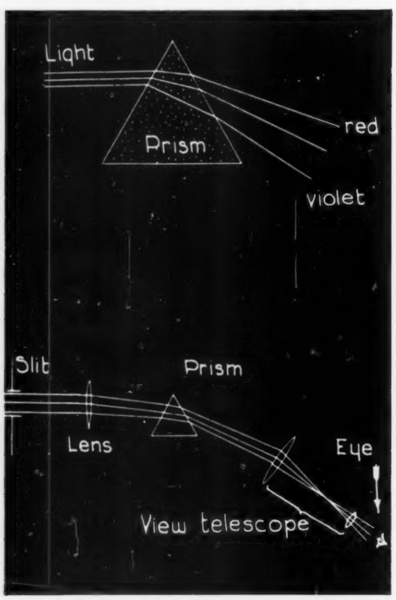
TERMINOLOGY TALKS — J. HUGH PRUETT

Colors in Nature

Dr. Walter S. Adams, retired director of the Mount Wilson Observatory, tells the story of a man who one day suddenly appeared in the doorway of the building where the astronomer was studying the spectrum of the sun. The visitor hinted that he had had some working experience with color pigments. Finally, when permitted to view the varicolored spectral band he took a long look, then came away and said, "I don't call that a very good green."

To some of us the "chromatic scale" of the solar spectrum is ethereally gorgeous. Only yesterday I discovered on the living room rug a colorful spot of light, which showed on a white piece of paper in orderly array all the exquisite shades of the rainbow. On one of the triangular glass ornaments standing on shelves of my wife's cactus window, the afternoon sun had fallen at just the proper angle to produce this spectacular effect.

Concerning the beauties found in the physical study of light, the late Dr. A. A. Michelson once said publicly, "If a poet could at the same time be a physicist, he might convey to others the pleasure, the satisfaction — almost the reverence — which the subject inspires. The aesthetic side of it is, I confess, by no means the least attractive to me.... I hope the day may be near when a Ruskin will be found equal to the description of the beauties of coloring."



The upper part of this diagram shows how differential refraction in a prism spreads light out into a spectrum. When a slit is used to keep the wave lengths separate as lines in the spectrum, a collimating lens is placed before the prism, as shown in the lower sketch.

Dispersion

There are phenomena of nature — the rainbow is one — whereby white sunlight is analyzed into its constituent colors. The same effect may be produced artificially by means of a prism. The refraction through one of its angles is similar to that through one edge of a lens, as shown in our Fig. 2 last month. But refraction is not all that takes place, for sunlight is composed of all colors, and the ratios between the speeds in air and glass are not the same for any two of them. As a result, some are bent more than others, and when they emerge from the prism into the air, they are spread apart an additional amount. This separation is known as *dispersion.* A sheet of white paper held in the path of these dispersed rays will be illuminated by a band of rich colors, with red on the side of least refraction, then orange, yellow, green, blue, and violet. Dispersion in a spectrum is a measure of the spread among the colors, or the separation of the wave lengths, and is usually expressed in angstroms per millimeter.

Vibgyor

We are sometimes told of the "seven colors of the rainbow," but there is seemingly no scientific basis for such a definite number. Many of us easily distinguish only five colors, although some say 12 would be a more correct number. The seven-color proponents break the blue into blue and indigo, with the latter next to the violet. Most of us know that tongue-twister, VIBGYOR, or perhaps you may prefer to remember it in reverse as ROYGBIV. Either way the letters stand for the initial of each color in the rainbow.

Spectral Lines

As has been inferred earlier, the spread of color is known as a spectrum. This is the Latin word for our word "specter," and means an image, an apparition, or a "visible disembodied spirit." Even to disbelievers in ghosts, the solar spectrum hints strongly of something majestically immaterial.

Should we replace the sun before the prism with a source of monochromatic light such as the luminous vapor of sodium chloride (common table salt) we would no longer find our sheet of white paper glowing with all colors. Instead only yellow would appear, and it would not spread over the entire space occupied by the VIBGYOR band; it would cover only a narrow portion where the yellow of sunlight fell and would be narrower than that yellow. If we vaporized a barium salt, we would see principally orange, green, and blue.

Let us arrange our apparatus so that the light from the vaporized sodium chloride passes through a small circular hole in cardboard before it reaches the prism. The image on our paper screen then becomes a circle. If the opening is changed to an elongated narrow slit, and a focusing lens is used, there is a yellow line on the paper. With the barium salt replacing the sodium salt, there appear on the screen about a dozen lines of various shades of orange, green, and blue.

This experiment indicates that each chemical gives off colors distinctive to itself, and that the shapes in which the bright spots on the screen appear are determined by the shape of the opening through which the light passes before reaching the prism. Since in more elaborate instruments these openings are usually narrow slits, the images in the various colors are a series of lines. This is the origin of the familiar term, "lines of the spectrum."

Spectroscope

It should be understood that the methods of producing spectra described above are the very crudest. In general laboratory practice and in the observatory much more efficient apparatus is used, but the principle involved is illustrated by the lower part of the diagram on this page. The slit is the real origin of the lines of the spectrum. The illuminated slit becomes a secondary source from which the rays of light diverge as they pass toward the prism. This necessitates a *collimating* lens to render the rays parallel to permit proper action by the prism. Then, when the light leaves the prism another lens is required to bring the parallel rays to a focus, and it is at this focus that the spectrum is formed. Here it may be examined with an eyepiece, so that the second lens and the eyepiece together form a *view telescope.*

Next month we shall continue with our discussion of the spectroscope.

HERE AND THERE WITH AMATEURS

*Members receive *Sky and Telescope* as a privilege of membership. †Member organizations of the Astronomical League.

State	*City*	*Organization*	*Time*	*Meeting Place*	*Communicate With*
ALABAMA	Gadsden	*Ala. A.A.*	7:30, 1st Thu.	Ala. Power Audit.	Brent L. Harrell, 1176*W* or 55
CALIFORNIA	Los Angeles	*L.A.A.S.*	7:45, 2nd Tue.	Griffith Obs.	H. L. Freeman, 853½ W. 57 St.
	Norwalk	*Excelsior Tel. Club*	7:00, Thu.	Excelsior Union H.S.	Geo. F. Joyner, 410 Sproul St.
	Oakland	**Eastbay A.S.*	8:00, 1st Sat.	Chabot Obs.	Miss H. E. Neall, 1626 Chestnut, B'keley
	Palo Alto	**Peninsula A.S*	7:30, 1st Fri.	Community Center	Mrs. D. Rossiter, 922 Roble Ave., Menlo Pk.
	Sacramento	**Sac. Val. A.S.*	8:00, 1st Tue., bi-mon.	Sacramento College	Mrs. B. Heathcote, 1820 G St., *Hudson* 4-1582
	San Diego	*Ast. Soc. of S.D.*	7:30, 1st Fri.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	*A.T.M. Ast. Club*	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	G. A. Sharpe, 4477 Muir, *Bayview* 3757
CONNECTICUT	New Haven	*†New Haven A.A.S.*	8:00, 4th Sat.	320 York St.	Mrs. Helen Velardi, 437 Wash., N'th Haven
	Norwalk	*Norwalk A.S.*	8:00, Last Fri.	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-5947
	Stamford	**Stamford A.A.*	8:00, 3rd Fri.	Stamford Museum	Wm. L. Dutton, Box 331, Noroton
DIST. COL.	Washington	*†Nat'l. Cap. Ast'mers*	8:00, 1st Sat.	Comm. Dept. Audit.	Janet Perkins, 2141 Eye St. NW (7), *Re* 7676
FLORIDA	Daytona Beach	*D. B. Stargazers*	8:00, Alt. Mon.	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
	Jacksonville	**J.A.A.C.*	8:00, 1st, 3rd Mon.	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
	Key West	*†Key West A.C.*	8:00, 1st Wed.	Private homes	W. M. Whitley, 1307 Div. St., 724-R
	Miami	*South'n Cross A.S.*	7:30, Every Fri.	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26 Rd.
GEORGIA	Atlanta	*Atlanta Ast'mers*	7:30, 3rd Fri.	Agnes Scott College	W. H. Close, 225 Forkner Dr., Decatur
ILLINOIS	Chicago	*†*Burnham A.S.*	8:00, 2nd Tue.	Chi. Acad. of Sci.	J. M. Showalter, 6200 Kenmore Ave.
	Geneva	**Fox Valley A.S.*	8:00, 1st Tue.	Geneva City Hall	Joseph Zoda, 501 S. 6th, St. Charles
	Moline	*†*Popular A.C.*	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, 3201 Coaltown Rd.
INDIANA	Indianapolis	*†Indiana A.S.*	2:15, 1st Sun.	Riley Library	E. W. Johnson, 808 Peoples Bank Bldg.
KANSAS	Topeka	**Topeka A.A.S.*	7:30, 2nd Mon.	Topeka H.S.	Miss N. Utschen, 1607 Wayne Ave.
	Wichita	*†*Wichita A.S.*	8:00, 1st Wed.	....	Dollie Ratcliff, 801 Maple, 2-1822
KENTUCKY	Louisville	*†L'ville A.S.*	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 621 34th St.
	Owensboro	*†*Owensboro A.C.*	8:00, 3rd Sat.	Public Library	Herman Batt, 1507 Hathaway St.
LOUISIANA	New Orleans	*A.S. of N.O.*	8:00, Last Wed.	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MAINE	Portland	*†A.S. of Maine*	8:00, 2nd Fri.	Private homes	H. Harris, 27 Victory Ave., S. Portland
MASSACHUSETTS	Cambridge	*†*Bond A.C.*	8:15, 1st Thu.	Harvard Obs.	C. A. Federer, Jr., Harvard Observatory
	Cambridge	*†*A.T.M.s of Boston*	8:00, 2nd Thu.	Harvard Obs.	J. Killion, 67 Roberts, Roslindale (31)
	Springfield	*†*S'field Stars*	8:00, 2nd Wed.	Private homes	F. D. Korkosz, Mus. Nat. Hist., 2-4317
	Worcester	*†*Aldrich A.S.*	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	Ralph A. Wright, 4 Mason St.
MICHIGAN	Ann Arbor	*†Ann Arbor A.A.A.*	7:30, 2nd Mon.	U. of Mich. Obs.	Stewart W. Taylor, 1106 Birk Ave.
	Battle Creek	*†B. C. A.A. Club*	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett St.
	Detroit	*†*Detroit A.S.*	3:00, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Detroit	*†*N.W. Detroit A.S.*	8:00, 1st Tue.	Redford H. S.	John W. Broxholm, 21412 Pickford
	Kalamazoo	*†Kalamazoo A.A.A.*	8:00, Sat.	Private homes	Mrs. G. Negrevski, 2218 Amherst, 31482
	Lansing	*†*Lansing A.A.*	8:00, 1st, 3rd Wed.	Technical H. S.	Mrs. T. A. Louden, 940 Bensch St. (14)
	Pontiac	*†*Pontiac A.A.A.*	8:00, 3rd Sun.	Cranbrook Inst.	Mrs. M. Chircop, 147 Prospect St., 21455
MINNESOTA	Duluth	*†*Darling A.C.*	8:00, 1st, 3rd Fri.	Darling Obs.	Mrs. A. Lynch, 1911 Wisconsin, Superior, Wis.
	Minneapolis	*M'polis A.C.*	7:30, 1st, 3rd Wed.	Public Library	Mrs. M. G. Simpson, 3220 Clinton, *Colfax* 4331
	St. Paul	*St. Paul Tel. Club*	7:30, 2nd, 4th Wed.	Macalester Coll.	Mrs. E. Pfremmer, 636 Grand Ave. (5)
MISSOURI	Fayette	*Central Mo. A.A.*	........, Last Sat.	Morrison Obs.	R. C. Maag, 611 Bluff St., Fulton
	Kansas City	**A.A. & T.M.s*	8:00, 4th Sat.	Private homes	Reginald Miller, Merriam, Kans.
	St. Louis	*St. Louis A.A.S.*	8:00, Sat.	Private homes	A. M. Obrecht, 2913 Park Ave.
NEVADA	Reno	*A.S. of Nev.*	8:00, 4th Wed.	Univ. of Nevada	E. W. Harris, University of Nevada
NEW JERSEY	Jersey City	*†Revere Boys Club*	7:15, Mon., Tue.	Gregory Mem. Obs.	Enos F. Jones, 339 Wayne St.
	Teaneck	*†Bergen Co. A.S.*	8:30, 2nd Wed.	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
NEW YORK	Buffalo	*†*A.T.M.s & Observers*	7:30, 1st, 3rd Wed.	Mus. of Science	R. M. Missert, 29 Crosby Ave., Kenmore
	New York	**A.A.A.*	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *En.* 2-8500
	New York	*†Junior A.C.*	7:30, 4th Fri.	Amer. Mus. Nat. Hist.	J. Rothschild, Hayden Plan., *En.* 2-8500
	Rochester	*Rochester A.C.*	8:00, Alt. Fri.	Rochester Museum	H. O. Woodard, 485 Hayward Ave. (9)
	Schenectady	*†S'tady A.C.*	8:00, 3rd Mon.	Schenectady Mus.	Miss Betty Douglas, 714 Altamont Ave.
	Wantagh	*Long Island A.S.*	8:00, Sat.	Private homes	A. R. Luechinger, Seaford Ave., 1571
N. CAROLINA	Greensboro	**Greensboro A.C.*	8:00, 1st Thu.	Woman's Coll., U.N.C.	Mrs. Edith Settan, 1030 W. Market St.
	Rocky Mount	*Hi-Y A.C.*	8:00, Tue.	YMCA	J. A. Harper, YMCA
	Winston-Salem	*†*Forsyth A.S.*	7:30, Last Fri.	Private homes	Kenneth Shepherd, 1339 W. 4th St.
OHIO	Akron	*A.C. of Akron*	8:00, 2nd Fri.	Beth.-Luth. Church	Mrs. R. J. Couts, 878 Kennebec Ave. (5)
	Cincinnati	**Cin. A.A.*	8:00, 2nd Fri.	Cincinnati Obs.	T. R. Stoner, RR 8, Cin. 30, *Be.* 7937-R
	Cincinnati	**Cin. A.S.*	8:00, 3rd Wed.	5556 Raceview Ave.	A. Moore, Hopkins & Letitia Sts., Amelia
	Cleveland	*†Cleveland A.S.*	8:00, Fri.	Warner & Swasey Obs.	Mrs. S. K. Towson, Warner & Swasey Obs.
	Columbus	**Columbus A.S.*	8:00, Last Tue.	McMillin Obs.	J. A. Hynek, Ohio State Univ.
	Dayton	*A.T.M.s of Dayton*	3rd Sat. Eve.	Private homes	F. E. Sutter, RR 7, Bx. 253A (9)
	Lorain-Elyria	*Black River A.S.*	8:00, 2nd Mon.	Clearview School	Louis Rick, Box 231, Lorain
	Warren	*†Mahoning Val. A.S.*	8:00, Thu.	Private homes	S. A. Hoynos, 1574 Sheridan, NE, 25034
	Youngstown	**Y'town A.C.*	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 905 Brentwood
OREGON	Portland	*†*Portland A.S.*	7:00, 1st Wed.	Central Pub. Lib.	H. J. Carruthers, 427 S. E. 61 Ave.
	Portland	*†A.T.M. & Observers*	8:00, 2nd Tue.	Private homes	N. C. Smale, 831 N. Watts St.
PENNSYLVANIA	Beaver	*†*Beaver Co. A.A.A.*	8:00, 4th Tue.	Com'y Bldg., Tamaqui	Mrs. R. T. LuCaric, Box 463, Baden
	Philadelphia	*†A.A. of F.I.*	8:00, 3rd Fri.	Franklin Institute	Edwin F. Bailey, *Rit.* 3050
	Philadelphia	**Rittenhouse A.S.*	8:00, 2nd Fri.	Morgan Physics, U.Pa.	Sarah Lippincott, Sproul Obs., Swarthmore
	Pittsburgh	*†*A.A.A. of P'burgh*	8:00, 2nd Fri.	Buhl Planetarium	Charles H. LeRoy, R.D. 11 (15)
RHODE ISLAND	Providence	*Skyscrapers, Inc.*	8:00, Mon. or Wed.	Ladd Observatory	Ladd Obs., Brown U., *Ga.* 1633
S. CAROLINA	Columbia	*North'n Cross A.S.*	8:15, Every Mon.	Melton Observatory	Dr. L. V. Robinson, Univ. of S. C.
TENNESSEE	Chattanooga	**Barnard A.S.*	8:00, 2nd Fri.	Jones Observatory	C. T. Jones, 302 James Bldg., 7-1936
	Nashville	**Barnard A.S.*	7:30, 2nd Thu.	Vanderbilt Univ.	Miss J. Saffer, 446 Humphrey St. (10)
TEXAS	Dallas	*†Texas A.S.*	8:00, 4th Tue.	Various auditoriums	E. M. Brewer, 5218 Morningside, *U6*-3894
	Ft. Worth	**Ft. Worth A.S.*	8:00, 4th Fri.	Texas Christian U.	L. C. Eastland, 5501 Byers Ave. (7)
	Houston	*Houston A.S.*	7:30, Last Fri.	Mus. Nat. Hist. Annex	Mrs. J. Murray, 1007 W. Gray (6)
UTAH	Salt Lake City	*A.S. of Utah*	8:00, 2nd Fri.	City and County Bldg.	Junius J. Hayes, 1148 East 1 S.
VERMONT	Springfield	*†Springfield T.M.'s*	6:00, 1st Sat.	Stellafane	John W. Lovely, 27 Pearl St., 535-W
VIRGINIA	Norfolk	*†*A.A.S. of Norfolk*	8:00, 2nd, 4th Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau, 21745
WASHINGTON	Tacoma	*Tacoma A.A.*	8:00, 1st Mon.	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 N. Union Ave.
	Yakima	*†*Yak. Am. Ast'mers*	8:00, 2nd Mon.	Cha. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.
WISCONSIN	Madison	*†Madison A.S.*	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	*†*Milw. A.S.*	8:00, 2nd Mon.	Public Museum	E. A. Halbach, 2971 S. 52 St., W. Allis
CANADA	Montreal	*RASC, Montreal*	8:00, Every Sat.	4052 Wilson Ave.	DeLisle Garneau, *Dexter* 1802

BOOKS AND THE SKY

THE STARS IN OUR HEAVEN

Peter Lum. Pantheon Books, New York, 1948. 245 pages. $3.75.

THIS VOLUME of beautiful legends should awaken the interest of the reader to look up at the sky and learn the constellation figures which have had such significance to various people the world over. The book is well printed on good paper, with 24 full-page illustrations and diagrams by Anne Marie Jauss.

The main divisions of the volume tell of the Northern Stars, the Zodiac, the Zodiacal Constellations, the Southern Stars, and the Milky Way. Dozens of different stories from different peoples and races are retold about individual constellations. For Ursa Major, stories are described from India, Greece, the Euphrates Valley, Arabia, China, Britain, several North American Indian tribes, and Scandinavia.

The drawings of the constellations are attractively done, with white stars and white-outlined figures on a full-page black background. In some cases the perspective or emphasis seems not quite true. For example, the W in Cassiopeia appears somewhat distorted, and Orion's sword has been more commonly portrayed as curved in the opposite direction. The northern constellation of Musca, no longer recognized, is pictured facing page 128 and on page 200, whereas the true southern Musca is represented on page 231.

As the subtitle, Myths and Fables, indicates, the book is concerned with the myths of the constellations, and not with their astronomical aspects. The appearance of the sky at different latitudes and for different seasons is well described; otherwise there is little pure astronomy in the book, and some of the astronomical statements are misleading. The statement on page 14 that the shift of the pole is so slight that it cannot be observed in three lifetimes should be qualified by the addition of "with the unaided eye." In the introduction it is stated that our moon travels through 28 constellations in the course of one month. This startles an astronomer until he figures out that Asiatic lunar mansions are meant.

The book should have considerable appeal for the lay reader, and should inspire people who read the myths to go out under the heavens and see the ancient stars for themselves. Most readers would appreciate an index and a page or two of references to the sources used in this anthology of star myths.

HELEN SAWYER HOGG
David Dunlap Observatory

POPULAR STAR ATLAS

Published by Gall and Inglis, 12 Newington Road, Edinburgh, 1949. Unpaged. $1.60 in U.S.A.

NORTON'S **Star Atlas** has long been a standard guide to the heavens for professional and amateur astronomer alike, but for general use or for naked-eye work only it often proves to be more detailed than necessary or desirable. To meet the need for an "intermediate character" in a set of star charts, Gall and Inglis has published this new **Popular Star Atlas.**

The charts themselves have been drawn by the author of Norton's **Star Atlas,** and they have the same basic design as those in the larger book, but are reproduced on a realistic dark blue background that should facilitate their use outdoors at night. Stars down to magnitude 5½ are included, together with Bayer designations, and Flamsteed numbers where necessary. The constellation boundaries are shown, and the epoch of the charts is 1950 — that is, the right ascension and declination co-ordinates are corrected for the effects of precession to their present positions against the stars. This is also true, of course, for the latest editions of Norton's **Star Atlas.** The Milky Way is realistically shown as a "salting" of the blue sky.

The circumpolar charts extend 40° - 60° from each pole, thereby helping to tie in with the principal charts, each of which covers at least five hours of right ascension and 60° of declination. There is descriptive material with each chart, and a list of observing objects intended for the naked eye and binoculars.

For use in the field during constellation study and meteor parties, this compact, well-bound set of charts should prove invaluable. Once a beginner has learned the fundamentals of the sky he will also make continual use of the **Popular Star Atlas.** Those whose Norton's are getting

dog-eared from overuse may well be able to place some of the strain conveniently on this abbreviated edition.

As it is believed a great many readers of **Sky and Telescope** will wish to obtain this atlas, Sky Publishing Corporation has made arrangements to accept prepaid orders for the American agents at the American retail price of $1.60 postpaid. Every attempt will be made to fill these orders within from two to four weeks of their receipt. Orders for Norton's **Star Atlas** may be made at the same time, at $5.25 postpaid. C. A. F.

PHILOSOPHY OF MATHEMATICS AND NATURAL SCIENCE

Hermann Weyl. Princeton University Press, Princeton, N. J., 1949. 311 pages. $5.00.

THIS IS a translation by Olaf Helmer, with numerous alterations of detail, of the author's classic **Philosophie der Mathematik und Naturwissenschaft,** 1926, from R. Oldenbourg's **Handbuch der Philosophie.** It will be welcomed by all whose knowledge of philosophical German is not always adequate for following the argument in the original. To bring the book up to date, the author has added six illuminating appendices on the structure of mathematics, ars combinatoria, quantum physics and causality, chemical valence and the hierarchy of structures, physics and biology, the main features of the physical world — morphe and evolution. These are most suggestive and alone are well worth the price of the book. The reader might do worse than to explore these first.

The book is not light reading. It is packed solid with close reasoning. In particular, "philosophy" in the title is to be taken seriously and technically. Mathematicians and physicists will probably have less difficulty than professional philosophers in understanding and appreciating Professor Weyl's masterly exposition. The treatment is condensed and suggestively allusive, making heavy demands on the reader's knowledge. There is much historical material going back to original sources. Only one with an erudition and grasp of the many difficult questions discussed comparable to the author's could do the book justice. The reviewer makes no pretension to the implied competence. The learning displayed is immense and impressive in both science and philosophy.

An occasional Greek word will not bother any student of the histories of mathematics and philosophy, but what about the untranslated Dutch of Brouwer on page 61? It has been said, perhaps justly, that only those who understand Dutch can understand Brouwer. However, the author does give a thorough exposition in as simple English as may be possible of Brouwer's ideas, revolutionary a third of a century ago, respectable and almost staid today. It should be remembered that Weyl himself was a pioneer in the foundations of mathematics, although he hardly says so. One commends this profound book, which only Weyl could have written.

E. T. BELL
California Institute of Technology

LIFE ON OTHER WORLDS

H. Spencer Jones. New American Library, New York, 1949. 160 pages. 35 cents.

NOW, even more than at the time it was first written, Spencer Jones' **Life on Other Worlds** should be of value and interest to the layman. With the advent of high-altitude rockets, current speculations by the military on the feasibility of man-made earth satellites, and the generally discussed hope for space ships to the moon and Mars, it becomes increasingly important for all of us to be aware of conditions throughout the solar system. Hence we welcome the appearance of this authentic classic in the new pocket edition.

Since this book's original publication by Macmillan in 1940, planetary astronomy has made important advances which have not been incorporated into this new printing. Some of the recent research is briefly summarized by Dr. Joseph Ashbrook, Yale University Observatory, in the October, 1949, **Scientific Monthly**, under the title, "The Meteorology of Other Planets." The new developments, however, in no way invalidate the Astronomer Royal's overall conclusions, in particular on the unsuitability of the other globes of the solar system for habitation by humans.

The pocket edition is unabridged; even the illustrations are included. In fact, the jacket illustration is extra, but it shows the Palomar dome with the shutters wide open, but no opening in the apparently solid dome for the telescope to peek out! DORRIT HOFFLEIT
Harvard College Observatory

NEW BOOKS RECEIVED

GEOLOGY APPLIED TO SELENOLOGY: IV — THE SHRUNKEN MOON, *J. E. Spurr*, 1949, *Business Press*, Lancaster, Pa. 207 pages. $4.00.

The fourth in the author's series in which he discusses the origin of the moon's surface features in the light of current geological principles.

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

AN EIGHT-DAY CLOCK DRIVE

IT IS POSSIBLE to "soup up" an ordinary spring-driven 8-day clock by several methods until it makes an ideal drive for a portable telescope. This has the advantages of providing a powerful drive rather than just a regulator for some other motive force, and yet no specific gear ratios are required. With a little ingenuity, any available gears may be used from the clock to the telescope.

The methods that may be employed are:

1. Remove one of the gears between the minute-hand gear and the escapement wheel. This can be done by drilling new bearing holes for whichever of the two gears remains, at the appropriate places. Also, the escapement wheel must be inverted because of the change of direction of rotation.

2. Remove some teeth from the escapement wheel, but leave three teeth out of the 15. This is generally most suitable. Beware of leaving five, because the interval between the pins allowing escapement is 2½ teeth, and only with one out of five teeth left will the escapement wheel move in uniform intervals.

3. Reduce the moment of inertia of the balance wheel to whatever might be the necessary amount. This varies approximately directly with the length of circumference left on the rim, and the period of the balance is then changed in proportion to the square root of the change in inertia. It is practical to remove up to two thirds of the rim of the balance.

4. Shorten the length of the hairspring. This is a very limited procedure and should be used only as a fine adjustment on method 3. Also, it is necessary to slip the axle in the hairspring hub so as to line up the pin on the balance wheel with the escapement lever in the neutral position.

Using these methods, the speed can be increased up to about 60 times. Although the spring unwinds that much faster, it provides ample power for even a crudely balanced telescope. It is also suggested that the minute-hand clutch be locked or tightened, if that shaft is to be the drive shaft.

It is advised, of course, that one contemplating such changes as here suggested first become used to the workings of clocks and try these procedures on a spare clock. I will gladly supply any further information to those who wish to write to me, since clarity has been sacrificed for brevity in this note.

LAWRENCE MERTZ
321 Witherspoon Hall
Princeton University
Princeton, N. J.

A SLIDING TELESCOPE TUBE

MY telescope mounting is made of 1¼-inch pipe and fittings. The upright has a steel rod bent to about 38 degrees and secured in the pipe by two set screws. A ⅜-inch bolt with two wing nuts raises the north end of the stand to compensate for uneven ground and to help align the steel rod with the earth's axis.

The unique part of the mounting involves an arrangement whereby the telescope tube may slide along its attachment to the mounting. This has the advantage of not tending to draw the telescope out of shape, and the telescope is easily set up and taken down. The tube may be set anywhere along the angle iron "ways" to obtain easy balance. No clamping bands pass around the tube.

Two lengths of 1¼-inch angle iron about two feet long are secured to the telescope with two edges facing each other, and separated enough to allow two ¼-inch bolts to pass between them. When wing nuts on the bolts are tightened, the angle

iron ways are clamped to a floor flange and a steel plate mounted on the end of the declination axis. The counterweight is an old 5-inch steam engine piston. The remainder of the mounting is made up of tees, nipples, and lengths of pipe in a rather conventional manner.

L. E. HOCKETT
214 East Ave. C
McPherson, Kan.

KITS FOR THE BEGINNER'S TELESCOPE

SINCE publication in the September issue of my article, "Telescopes for Juniors," and the specifications for a beginner's telescope in the Gleanings department, so many people have written us about our beginner's telescope that we have decided to make the kit of parts available to other places. We wish to invite all interested individuals and groups to communicate with the undersigned.

Each kit of parts is available at $2.50, shipped postpaid, but a carton of five kits is $10.00, or only $2.00 per kit. A carton of 10 kits is $17.50, or $1.75 per kit. These kits do not include the lenses, which must be obtained directly from the war surplus company at 44 cents per set.

Separately, group leaders may wish to have a complete instruction manual, which has been compiled for $1.00 a copy, and a demonstration telescope made up complete with lenses for $5.00. This instrument can be completely disassembled to show how the parts are finished and how they go together.

As it is our purpose to help meet the astronomical interests of young people, kits in cartons and demonstration telescopes are available only to astronomy clubs, or others who are starting junior astronomy clubs sponsored by scout, school, rotary, church, or other civic groups, and who resell to youngsters at our cost. We are making these kits with volunteer labor of our Junior Astronomy Club members to help other youngsters in other cities learn about astronomy.

As we have to do the preparation and packing at times convenient to the volunteer workers, we cannot guarantee prompt shipment, and will fill orders on a first-come, first-served basis. By the time this announcement appears, however, we hope to have several hundred kits packed and ready to ship.

We are keeping in close touch with Grace C. Scholz, executive secretary of the Astronomical League and director of its junior activities program, and already we have circularized a list of individuals who are operating junior programs or planning them, and we have sent a letter similar to this to the officers and regional chairmen of the Astronomical League.

FRANK A. MYERS
Junior Astronomy Club
Cleveland Museum of Natural History
2717 Euclid Ave., Cleveland 15, Ohio

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comment, contributions, and questions from its readers.

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

"Elusive" Mercury — Monthly Observations in 1949

It has made an interesting part of my observing program this year to test the Copernican legend regarding the visibility of Mercury. My idea was to see if it were possible to detect the planet at least once during every month of the year. A glance at the 1949 Maryland Academy Graphic Time Table of the Heavens made it apparent that 1949 was a good year for such an attempt inasmuch as the three least favorable elongations reached their maxima near the turn of the month. Most of the observations were made with the naked eye, but some required the use of a 6 x 30 binocular.

One must remember in considering this 1949 observing stint that there are other ways in which a statement that Mercury can be observed at any time of the year in mid-latitudes may be interpreted. Over a seven-year period, the sweep of both favorable and unfavorable morning and evening appearances together cover the entire year. The 1949 feat may be impossible in such years as bring a superior conjunction in the middle of the month, even though in that calendar year the planet may be observed at every one of its six or seven elongations. Such is the case in 1950, when I challenge anyone to make a low-power observation in mid-northern latitudes in March (see Graphic Time Table of the Heavens, page 62).

My monthly observations of Mercury during 1949 were recorded as follows:

January. The planet was favorably observed a number of times during this elongation. An attempt to observe its conjunction with Mars was made on the evening of the 7th. On both that night and the following one, Mercury was visible to the naked eye while Mars required the use of the binocular.

February. Mercury was easily seen with the naked eye on the morning of the 18th, while Venus was barely detected some distance below it. Poor definition due to low altitude and atmospheric conditions made it difficult or impossible to identify the crescent phase in a 20x telescope.

March. The planet was on the border line of naked-eye visibility the morning of the 2nd, but was conspicuous in the binocular. There was a slight haze in the sky; otherwise it would probably have been easy to see Mercury without optical aid.

April. The month's observations were highlighted by the close conjunction with the moon on the evening of the 29th. As early as 20 minutes after sunset the planet could be seen in the binocular, while gathering darkness later disclosed the Pleiades within the same field of view and made it possible to check the motion of the moon across the background of stars before the planet set.

May. A very clear evening on the 10th permitted a fine view at greatest elongation. This also was the first occasion on which Venus was seen with the naked eye after sunset following superior conjunction in April.

June. The only successful observation this month came on the morning of the 28th when the beautiful triangle of Mercury, Mars, and Aldebaran was seen within the field of view of the binocular. Haze brightened the sky and prevented naked-eye verification.

July. A very clear sky on the morning of the 8th permitted naked-eye views of Mercury, Mars, and Beta Tauri.

August. On the evening of the 13th, Mercury could be seen with moderate ease in the binocular but could not be detected with the naked eye. Saturn had just passed conjunction with Mercury but could not be found even in the binocular. I wonder what would have been seen in an unusually clear sky — this one was about average.

September. A sky devoid of clouds and of better-than-average clarity permitted an excellent test of visibility of stars and planets low in the evening twilight of the 2nd. Again Mercury was easily seen in the binocular but not with the naked eye. Its position and that of Venus were plotted on a tracing of the Skalnate Pleso **Atlas,** along with bright Virgo stars and Denebola, from co-ordinates in the **American Ephemeris.** This was a great help in locating the objects quickly, with Venus, of course, as a reference.

October. The planet was first seen during its favorable western elongation on the clear, frosty morning of October 16th. It was a brilliant naked-eye object. An anticipated close approach of the crescent moon to Mercury on the 20th was obscured by clouds.

November. An observation was made without optical aid on the 2nd, a beautiful morning to see a rather faint flaming aurora in the north, the zodiacal light to the east, and finally the planet itself in the dawn just a little below and to the left of Spica. The star was clearly seen with the naked eye before Mercury came into view, and the setting recalled a year ago when many of us were sweeping that region of the skies for a view of Comet 1948l.

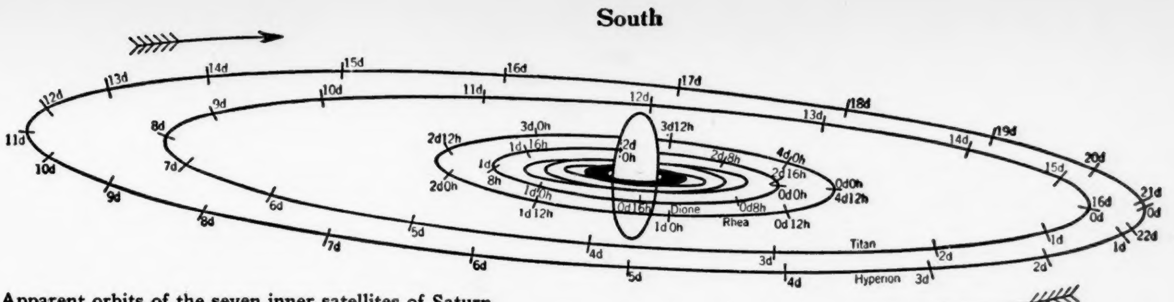
December. Observations cannot be made during this month before **Sky and Telescope** goes to press, but I have no doubt of concluding this series with evening views of the Mercury-Venus-Jupiter configuration with the crescent moon during the latter part of the month.

PAUL W. STEVENS
2322 Westfall Rd.
Rochester 18, N. Y.

MOON PHASES AND DISTANCE

Full moon	January	4, 7:48
Last quarter	January	11, 10:31
New moon	January	18, 7:59
First quarter	January	26, 4:39
Full moon	February	2, 22:16

	January	Distance	Diameter
Perigee	13d 6h	229,700 miles	32′ 19″
Apogee	25d 22h	251,200 miles	29′ 33″



Apparent orbits of the seven inner satellites of Saturn, at the time of the planet's opposition, March 7, 1950, and as seen in an inverting telescope.

SATELLITES OF SATURN

Although Saturn does not reach opposition until March 7th, interest in its rings and satellites is very great this year because the rings are nearly edgewise to our line of sight. In the diagram reproduced here from the **American Ephemeris and Nautical Almanac** the vertical dimension has been elongated three times in relation to the horizontal dimension, in order to permit showing the satellite orbits separately. The eastern elongation point of each satellite's orbit is marked 0d 0h or 0d (except for the three innermost satellites). The times of eastern elongation are listed in the **Ephemeris**, and some selected elongation times for Tethys, Dione, Rhea, and Titan are given below.

The apparent position of a satellite at any time may be marked on the diagram by setting off on the proper orbit the elapsed interval in days and hours since the last eastern elongation. The orbits of the five inner satellites are regarded as circular, but for Titan and Hyperion the eccentricity is taken into account. The satellites, with their apparent angular distances from the planet (as seen from the sun) are:

Satellite	Synodic Period days	hours	Magnitude	Mean Distance
Mimas	0	22.6	12.1	27″
Enceladus	1	8.9	11.6	34″
Tethys	1	21.3	10.5	43″
Dione	2	17.7	10.7	55″
Rhea	4	12.5	10.0	76″
Titan	15	23.3	8.3	177″
Hyperion	21	7.6	13.0	214″
Iapetus	79	22.1	10.1-11.9	515″
Phoebe	523	15.6	14.5	1870″

For Tethys, Rhea, and Dione the times given below are for every fourth eastern elongation, but for Titan the configurations around the orbit are given: E, eastern elongation; I, inferior conjunction; W, western elongation; S, superior conjunction. In all cases the month is given, then the day of the month and the hour of the day in tenths, Universal time. For instance, for Titan the first event is a western elongation that occurs on January 3rd at $9^h.9$ UT.

Tethys. January: 2, 12.7; 10, 1.9; 17, 15.1; 25, 4.3. February: 1, 17.5; 9, 6.7; 16, 19.8; 24, 9.0. March: 3, 22.1; 11, 11.3; 19, 0.5; 26, 13.6. April: 3, 2.8; 10, 16.0; 18, 5.2; 25, 18.4. May: 3, 7.6; 10, 20.8; 18, 10.0; 25, 23.3. June: 2, 12.5.

Dione. January: 2, 12.1; 13, 10.8; 24, 9.5. February: 4, 8.1; 15, 6.7; 26, 5.3. March: 9, 3.9; 20, 2.6; 31, 1.2. April: 10, 23.8; 21, 22.5. May: 2, 21.3; 13, 19.9; 24, 18.7. June: 4, 17.5.

Rhea. January: 4, 19.2; 22, 20.7. February: 9, 22.2; 27, 23.5. March: 18, 0.8. April: 5, 2.2; 23, 3.6. May: 11, 5.2; 29, 6.8.

Titan. January: W, 3, 9.9; S, 7, 14.6; E, 11, 14.3; I, 15, 9.0; W, 19, 8.3; S, 23, 12.8; E, 27, 12.5; I, 31, 7.1. February: W, 4, 6.2; S, 8, 10.7; E, 12, 10.3; I, 16, 4.9; W, 20, 3.8; S, 24, 8.3; E, 28, 8.0. March: I, 4, 2.5; W, 8, 1.3; S, 12, 5.7; E, 16, 5.5; I, 20, 0.0; W, 23, 22.8; S, 28, 3.2. April: E, 1, 3.2; I, 4, 21.7; W, 8, 20.5; S, 13, 0.9; E, 17, 1.0; I, 20, 19.7; W, 24, 18.5; S, 28, 23.0. May: E, 2, 23.2; I, 6, 18.0; W, 10, 16.8; S, 14, 21.5; E, 18, 21.8; I, 22, 16.7; W, 26, 15.6; S, 30, 20.4.

VISIBILITY OF VENUS

The brightest planet is of special interest as it nears and passes inferior conjunction with the sun on January 31st at 7:00 Universal time. It should be possible for observers in northern latitudes to follow Venus every clear evening up through conjunction and to pick it up in the morning sky before sunrise at the same dates. The Graphic Time Table of the Heavens in this issue of **Sky and Telescope** shows that three days before conjunction the planet will set about 30 minutes after the sun for latitude 40° north, but the following morning it will rise 20 or 25 minutes ahead of the sun. In a similar situation in February, 1942, the writer saw Venus with the unaided eye three days before conjunction. This was from the center of New York City and the planet was followed for 20 minutes.

At conjunction, Venus will be of magnitude −3.2, its crescent exceedingly thin but 62″ in diameter. On January 31st, look for Venus at sunset or earlier, searching well north of the sun, which the planet follows below the horizon by 15 minutes. Opera glasses will be of great help, and binoculars will be essential to see the planet at noontime. Look about 15 solar diameters north of the sun — observing Venus this way has been achieved by many amateurs in the past. E. O.

VARIABLE STAR MAXIMA

January 2, R Leonis, 5.9, 094211; 4, R Phoenicis, 7.8, 2351**50**; 6, V Cassiopeiae, 7.9, 230759; 14, S Carinae, 5.7, 1006**61**; 18, R Virginis, 6.9, 123307; 20, T Centauri, 6.1, 1336**33**; 26, R Cassiopeiae, 6.5, 235350.

These predictions of variable star maxima are by Leon Campbell, honorary recorder of the AAVSO. Only stars are included whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

OCCULTATION PREDICTIONS

SPICA and the Pleiades will be occulted this month, but the second event will be more easily observed than the first. For the occultation of Spica on January 11th occurs during morning daylight hours except on the West Coast, whereas stars in the Pleiades will be occulted for Texas observers and others in the Southwest during convenient evening hours of January 27th. The star 23 Tauri is Merope; Eta is 25 Tauri, best known as Alcyone; and 27 Tauri is a double star named Atlas. The passage of the moon through the Pleiades that evening will be a fine sight for observers everywhere in the United States.

January 2-3 **136 Tauri** 4.5, 5:50.2 +27-36.1, 14, Im: **G** 1:18.0 −0.3 +1.3 101; **H** 1:03.2 −0.6 +0.1 126; **I** 1:14.5 0.0 +1.4 92. Em: **H** 1:41.5 + 0.7 +2.7 209.

January 10-11 **Alpha Virginis** 1.2, 13:22.6 −10-54.1, 22, Im: **A** 14:54.3 −0.7 −1.8 130; **B** 14:47.8 −0.8 −1.8 128; **C** 14:57.4 −0.8 −1.9 136; **D** 14:46.5 −0.9 −1.9 132; **E** 14:41.6 −1.0 −1.9 144; **F** 14:55.1 −0.8 −2.7 169; **G** 14:03.2 −0.6 −1.3 161; **I** 14:02.4 +0.1 −2.0 182. Em: **A** 15:55.6 −0.4 −1.7 284; **C** 15:58.9 −0.6 −1.6 280; **E** 15:46.4 −1.1 −1.6 279; **F** 15:47.4 −1.8 −0.8 260; **G** 15:01.2 −1.7 −0.8 269; **I** 14:43.7 −2.5 +0.3 251.

January 27-28 **23 Tauri** 4.2, 3:43.4 +23-47.6, 10, Im: **F** 4:20.0 −2.0 +1.4 45; **H** 3:56.9 ... ... 2. Em: **F** 5:31.2 −1.2 −2.2 288; **H** 4:35.1 ... ... 311.

January 27-28 **Eta Tauri** 3.0, 3:44.5 +23-57.1, 10, Im: **F** 5:27.7 ... ... 11. Em: **F** 5:56.3 ... ... 327.

January 27-28 **27 Tauri m** 3.8, 3:46.2 +23-54.1, 10, Im: **F** 6:04.7 −1.3 +0.4 53; **H** 5:31.2 −1.9 +1.4 44. Em: **F** 7:06.1 −0.1 −2.0 291; **H** 6:42.9 −1.3 −2.2 287.

January 29-30 **136 Tauri** 4.5, 5:50.2 +27-36.1, 12, Im: **I** 12:26.4 +0.5 −1.6 117.

January 30-31 **49 Aurigae** 5.0, 6:32.1 +28-03.8, 13, Im: **A** 5:25.9 −1.5 −0.6 76; **B** 5:22.9 −1.7 −0.2 68; **C** 5:21.5 −1.5 −1.0 93; **D** 5:13.8 −1.7 −0.5 81; **E** 4:55.4 −1.8 −1.1 104; **F** 5:00.4 −1.8 −3.7 146; **G** 4:15.3 −1.4 +1.5 68; **H** 3:55.7 −2.3 −0.6 119; **I** 4:01.1 −1.2 +1.8 68. Em: **A** 6:30.1 −0.3 −2.4 309; **C** 6:35.4 −0.8 −1.9 293; **E** 6:18.0 −1.6 −1.2 276; **F** 6:04.3 −3.1 +1.7 233; **H** 5:13.8 −2.1 +1.8 240.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computations of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo — LoS**), and multiply **b** by the difference in latitude (**L — LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	E +91°.0, +40°.0
B +73°.6, +45°.6	F +98°.0, +30°.0
C +77°.1, +38°.9	G +114°.0, +50°.9
D +79°.4, +43°.7	H +120°.0, +36°.0
I +123°.1, +49°.5	

APPROXIMATE SIDEREAL TIME

A COMMON METHOD for finding the approximate sidereal time begins with the fact that mean time and sidereal time are the same on or about September 21st. A correction is applied to the mean time at a later date, depending upon the interval elapsed since September 21st.

The following method is believed to be simpler in application and is easily remembered. Add together the four terms:

(A) A constant, 4 hr. 39 min. for a standard time meridian.

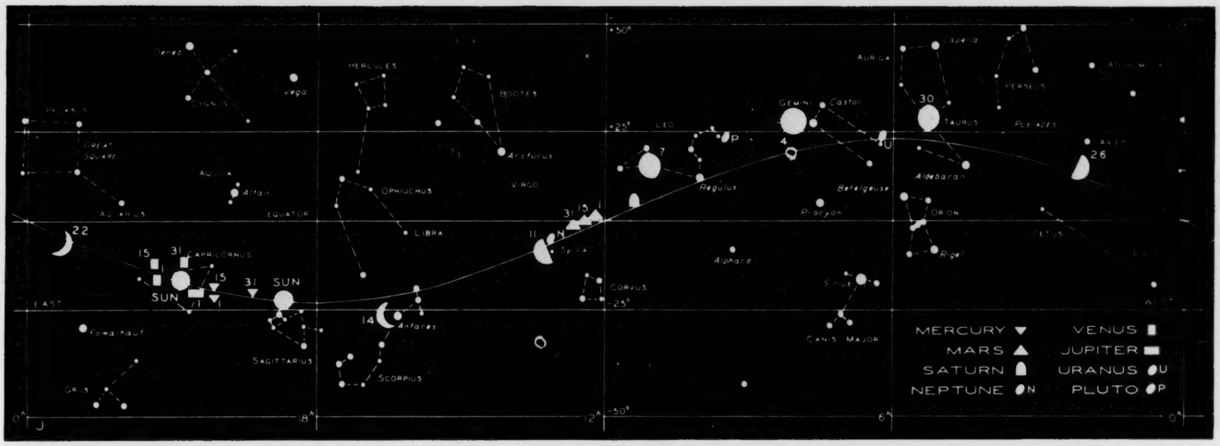
(B) 2 hr. times the number of the month, counting January as 1, February as 2, and so forth.

(C) 4 min. times the day of the month.

(D) Standard time, plus 12 hr. for p.m. times.

Then subtract 24 successively from the sum until the remainder is less than 24 hr. The answer is the approximate sidereal time.

As most observers will not be located right on a standard time meridian, the constant term must be modified by adding the difference in longitude from the stand-



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

ard meridian if the observer is to the east of the standard meridian, or subtracting if west. For instance, Pittsburgh is 20 minutes west of the 75th meridian (Eastern standard time). The constant term becomes 4 hr. 39 min. minus 20 min., or 4 hr. 19 min. For Boston, 16 minutes east of the 75th meridian, the constant term is 4 hr. 55 min. Once this constant term (A) has been determined for a particular location, it is the same in all subsequent calculations throughout the year. One needs to remember only the constant for his location and the method of computing the remaining three terms.

EXAMPLE: Find the sidereal time at Pittsburgh, Pa., on December 25th at 11:30 p.m. EST.

(A) Constant term	4 hr.	19 min.
(B) Dec. 12 x 2 hr.	24	0
(C) Day 25 x 4 min.	1	40
(D) Time 11:30 p.m.	23	30
	—	—
Total	53	29
Subtract 2 x 24 hr.	48	0
	—	—
Approx. sidereal time	5 hr.	29 min.

The constant term in the rule was determined by noting in the **American Ephemeris** the average Greenwich sidereal time on January 1st, at 0^h UT, for the years 1947-1950. This was found to be $6^h\ 39^m\ 45^s$. Selecting noon for the 90th meridian (CST) as a median, the local sidereal time was calculated for 18^h at Greenwich.

Jan. 1 UT 0^h ST	6	39	45
Sid. time interval	18	2	57
	—	—	—
UT 18^h ST	0	42	42
Long. 90° west (—)	6	0	0
	—	—	—
Local sidereal time	18	42	42

The sum of terms B, C, and D for January 1, 12:00 noon is 14 hr. 4 min. Subtraction of this from the local sidereal time just computed gives 4 hr. 38 min. 42 sec., or 4 hr. 39 min. approximately, which is the constant term. It may be used for all of the standard time meridians in the United States and Canada and for other places with corresponding longitudes, and the resulting sidereal time will be within a very few minutes of its true value.

H. MALCOLM PRIEST
166 N. Dithridge St.
Pittsburgh 13, Pa.

Mercury opens the year at greatest elongation on January 1st, 19° 29′ east of the sun. Setting 1½ hours after the sun, the so-called elusive planet will be an easy object, of —0.4 magnitude. Mercury then rapidly fades from the evening sky, passing inferior conjunction on January 17th. The last few days of the month find the planet rising more than one hour before the sun and of the 1st magnitude.

Venus will be highly interesting to follow in January. Opening the month as a brilliant object of —4.4, setting three hours after the sun, it will then race toward the vicinity of the sun, passing inferior conjunction on January 31st. The disk of Venus on January 1st will be 45″ in diameter and 21 per cent illuminated. By mid-month, the planetary crescent may be viewed with field glasses as a thin splinter of light.

Mars, approaching opposition in March, now rises before midnight. The ruddy planet brightens from +0.8 to +0.1 magnitude in January. Moving eastward in Virgo, Mars passes 13′ north of Gamma on the 25-26. Along the zodiac, eastward from Regulus, one may view Saturn, Mars, and Spica, almost equally spaced, Mars outshining the others.

Jupiter may be found low in the southwest shortly after sunset during the first half of January. The planet will then disappear into the sun's glare, conjunction occurring February 3rd.

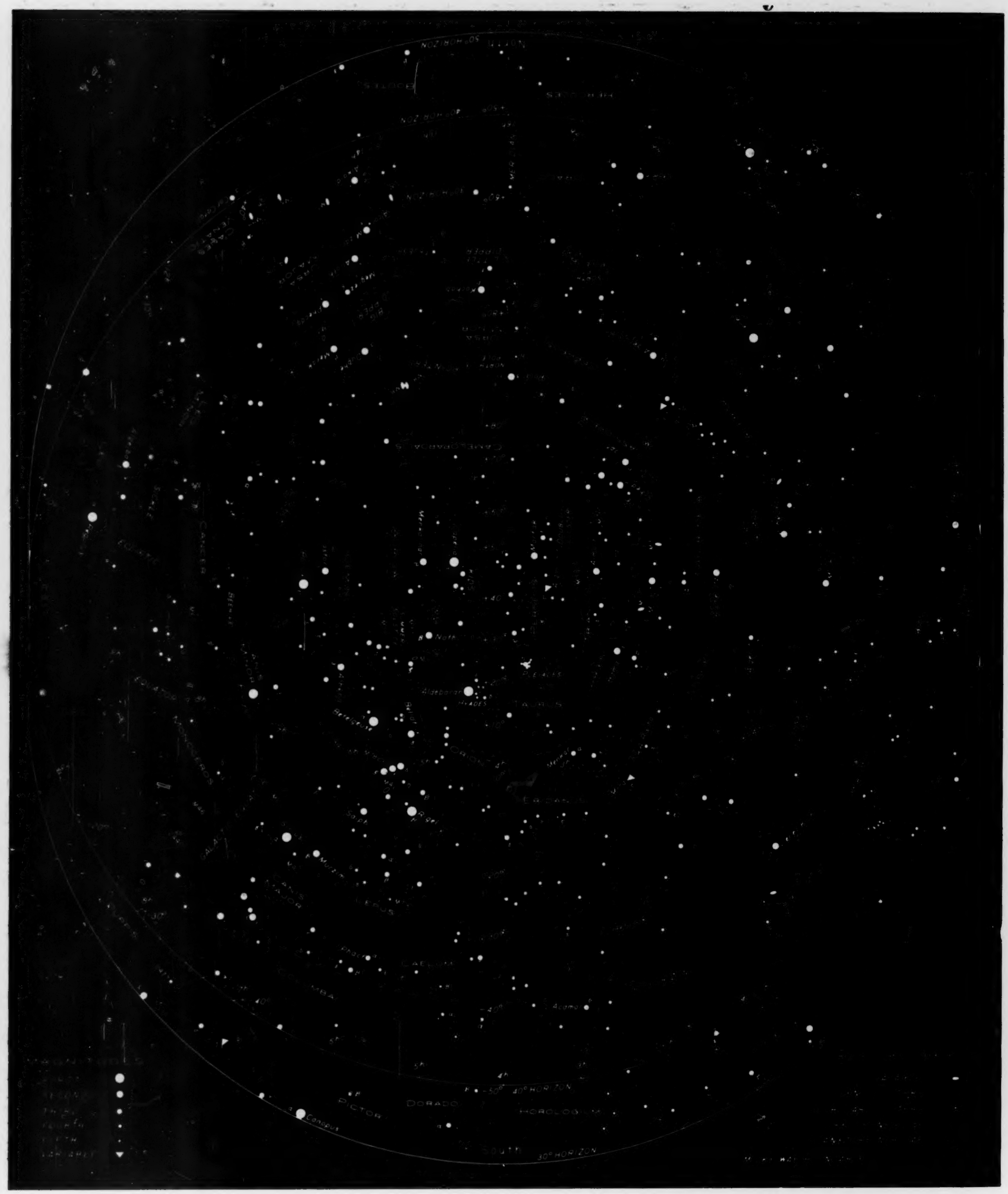
Saturn rises from five to three hours after sunset, in eastern Leo. In a telescope, the rings are tilted about 1½°; the southern face is the one visible. A close conjunction with the moon takes place on January 9th at 4:53 UT, with the planet 12′ north.

Uranus will be above the horizon most of the night. On December 31-January 1, it will be 1°.2 north of Eta Geminorum, moving in retrograde motion and of the 6th magnitude.

Neptune arrives at western quadrature with the sun on January 8th, hence rising about midnight. The planet is almost stationary all month, located about ¼° west of Theta Virginis. E. O.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.



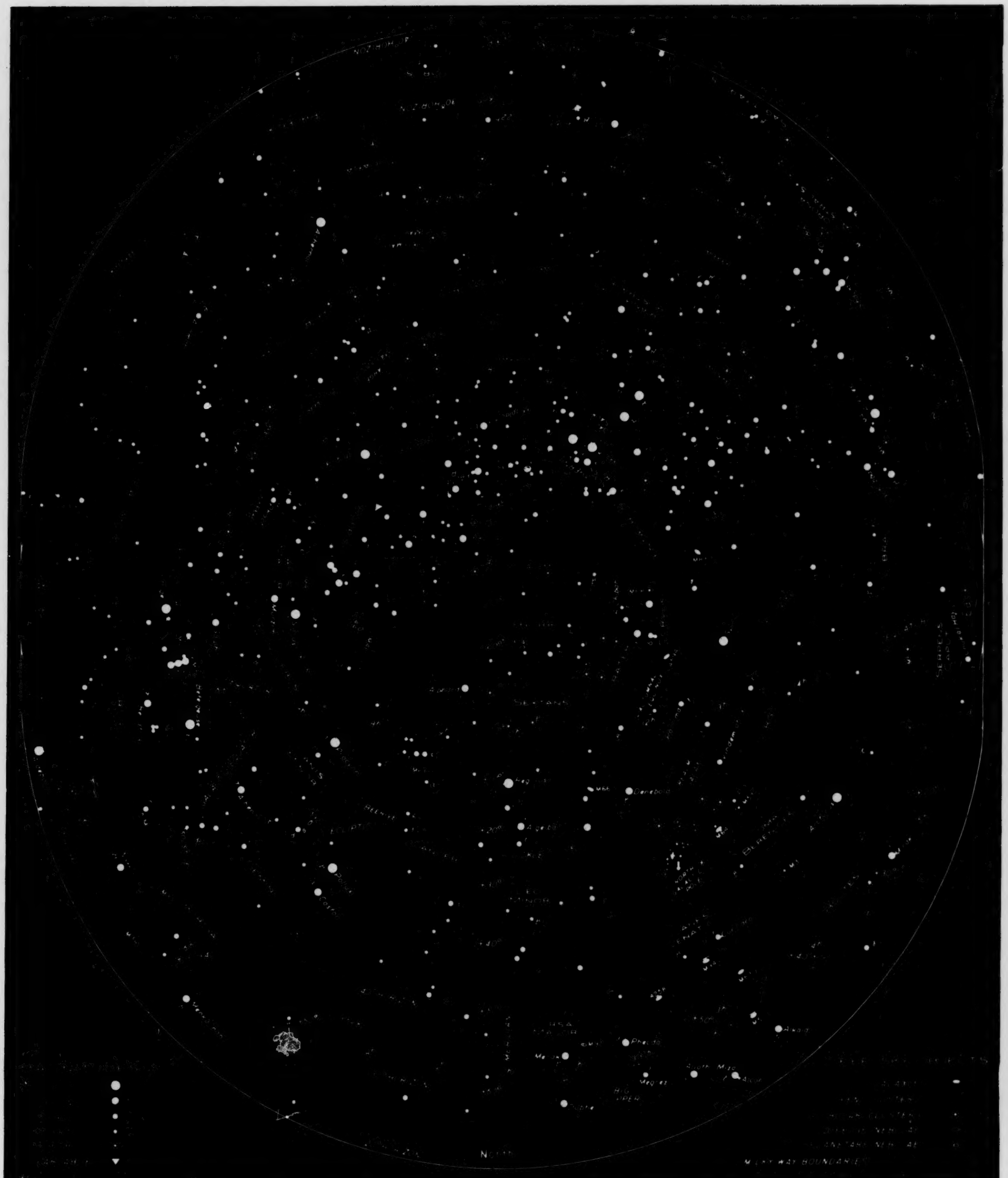
The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of January, respectively.

STARS FOR JANUARY

STAR CHARTS of many kinds are in use today but no one kind can fill all requirements. Where representation of the sky on a month-to-month basis is desired, our regular charts should prove satisfactory. They involve several compromises in an effort to make them as useful as possible to most readers.

Latitude of observer. The northern charts are designed to be of use to observers in the wide range of latitudes of the United States and southern Canada. Three horizons are shown on each chart. If you live, for instance, at latitude 35° north, your horizon is a circle running midway between the 30° and 40° horizons. At the time for which the above chart is drawn, the star Canopus will be below your horizon, as will also the last star in the handle of the Big Dipper. But for an observer at latitude 50° north, this star will be above the horizon, as will also Vega in the northwestern part of the sky. Note that the southern chart, on the facing page, has been drawn for the populated latitudes in the Southern Hemisphere from 20° to 40° south.

Chart times. The need to show a horizon on a chart of this kind requires that a certain time of night be stated, but this does not imply that the chart is useless



The sky as seen from latitudes 20° to 40° south, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of April, respectively.

SOUTHERN STARS

except at such a time. In the sky, any one hour circle crosses the upper meridian once each sidereal day, but at various times of day during the year as measured by our solar clocks. The variation is nearly four minutes earlier per day, half an hour a week, and two hours per month.

For this month's northern chart the 4^h circle is on the meridian; for the southern chart the 10^h circle is on the meridian, as it is fundamentally an April evening chart, published early to allow transmission to the Southern Hemisphere.

In using monthly charts such as these, which have been drawn for a particular time, it is possible to observe several hours before or after the chart time and still to compare constellations in the sky with their chart counterparts. If you are observing earlier than the specified chart time, however, some groups you see in the western sky may have "set" on the chart, and it will be necessary to refer to the chart for the preceding month to identify these groups. For example, after our early January sunsets, occurring in the United States about 5:00 p.m. local time, the sky becomes dark two or three hours before the chart times given. The December chart, therefore, may be used for early evening observing in January. On the other hand, before midnight the February chart becomes more appropriate to show the stars above the horizon.